Knowledge.

With which is incorporated Hardwicke's Science Gossip, and the Illustrated Scientific News.

A Monthly Record of Science.

Conducted by Wilfred Mark Webb, F.L.S., and E. S. Grew, M.A.

DECEMBER, 1912.

THE EVOLUTION OF THE CUCKOO.

By G. W. BULMAN, M.A., B.Sc.

THOSE who hold the theory of natural selection, looking back in time, see the Cuckoo as a bird with the normal instincts of its kind. Darwin was persuaded that even to-day it still sometimes shows traces of those ancestral instincts. "It has also recently been ascertained," he wrote, "on sufficient evidence, by Adolf Müller, that the Cuckoo occasionally lays her eggs on the bare ground, sits on them, and feeds her young." How, then, in the struggle for existence did it attain its present strange and unique position among the birds of our country? That instinct which leads it to hand over the care of its eggs and young to foster-parents is doubtless a *great advantage* from the Cuckoo's point of view. There results for it a life of ease, no troublesome nest-building, no trying work of brooding over eggs, no voracious young to be fed at the expense of much time and trouble. The Cuckoo is free to speed off for Africa's sunny shores early in July, while other birds are still toiling over their broods. For the individual cuckoo the advantages are obvious; its life becomes a "primrose path of dalliance." The advantages to the race, however, are not so obvious. It is not clear that the Cuckoo leaves a more numerous and stronger progeny than it would if it reared its brood in the usual way, or than it did while it was still respectable. This, of course, is mere speculation, but the fact remains that the Cuckoo is not specially numerous in this country. It is less so than many birds which rear their young in the ordinary way. But, waiving this doubt as to the possible ultimate advantage of the habit, let us go back to the commonplace respectable Cuckoo, or Cuckoo-like bird building its nest and hatching and rearing its own young. Some abnormal twist in the brain of a certain Cuckoo led it to pick up one of its eggs and place it in the nest of a Titlark. We will suppose it thus disposed of *all* its eggs, though we are not quite sure that the etiquette of natural selection would not bind us down to *one* in the first instance. Let us suppose that this brood is more successfully reared than those treated in the ordinary way. This might arise from the fact that the Cuckoos were careless nurses—though this is not a quality that could be evolved by natural selection. Or an adult Cuckoo may have been unable to feed a full brood as well as a Titlark could feed a single young Cuckoo. But, however it may have arisen, let us assume the advantage to have been with the Cuckoo which got its young reared by the Titlark. The quality or instinct which led the female Cuckoo to act thus would probably appear in *some* of the descendants, the rest inheriting normal instincts from paternal sources. But in the descendants of those which did inherit the new instinct, this would run a heavy risk of being swamped by intercrossing with others of normal instincts. This, however, is a very common difficulty in the case of an incipient new species, and we will suppose the new instinct managed to survive the flood. It might then be reinforced by the sporadic appearance of the like in other individuals. Those possessing the instinct would leave more numerous and stronger progeny, and those which did not adopt it would be finally weeded out by natural selection. Thus the Cuckoo race sauntered down a curious by-path of evolution to the idle life.

But if this be accepted as the general outline of the evolution of the Cuckoo there are also certain special points which call for attention. There are, for example, the strange instincts and actions of the young Cuckoo in the nest. In the Cuckoo's respectable days it cannot have been the little demon it now is. It cannot have been in the habit of turning its brothers and sisters and eggs out of the nest. So it probably had not then the convenient hollow in its back for holding the eggs. And yet these habits, instincts and structure seem absolutely essential to the well-being of the young Cuckoo. Only by turning everything else out of the nest can it obtain sufficient nourishment for itself. And yet the first Cuckoo hatched in a Titlark's nest cannot be supposed to have had these characters. It would get no advantage in the strange nest, and would probably be starved.

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The eggs of the Cuckoo have suggested another evolutionary problem. More than a hundred years ago, the naturalist Salerne gave currency to the idea that the egg of the Cuckoo resembles those beside which it is placed. He was himself hardly a believer in the assertion, but gave it on the authority of an inhabitant of Sologne. In 1853, Dr. Baldamus brought forward the same idea, and supported it by a series of eggs in his cabinet. But English ornithologists were slow to accept this view. They saw, for example, that in the case of the Hedge Sparrow, in whose nest the Cuckoo so frequently places its eggs, there was no resemblance at all. On the basis of the collection of Cuckoos' eggs in the Natural History Museum Sir Wm. Flower gives the following summing up of the question :—

"We have now a fine series of Cuckoos' eggs, with those of the birds in whose nests they were laid, showing in many cases a great resemblance in colour, in others none at all. In some Hedge Sparrows' nests the Cuckoos' eggs are as blue as the others; but in some they are of the more usual speckled-brown. It has been doubted whether the blue eggs were really those of the Cuckoo, but Mr. Seebohm set the question at rest by taking an undoubted young Cuckoo (with its very different feet from the Sparrow's) from one of them. The Cuckoos' eggs vary much in colour, and, generally speaking (though with many exceptions), show some conformity to the eggs of the bird in whose nest they are laid."

Professor Newton was inclined to accept the theory of the resemblance with the reservation that there are "numerous instances in which not the least similarity can be traced." Granted the resemblance, then, it is an obvious suggestion that its object is the more successfully to deceive the foster-parents. And this being so it admits of an explanation on the lines of natural selection, since those Cuckoos which most successfully palmed off their eggs on their dupes would succeed best in the struggle for existence. Thus the Cuckoo which laid a robin-like egg and placed it in a Robin's nest would succeed better than one whose egg had no resemblance to those of its host. And having once confided its egg to a Robin, a Cuckoo would be likely to continue doing so, and the daughters would be likely to inherit the habit. Thus there would be a tendency to produce separate races of Cuckoos, one laying blue eggs in Hedge Sparrows' nests, another blue brown-speckled eggs in Robins' nests and so on. It is easy to suggest objections to this explanation. In the first place it is not obvious that any deception is necessary. As a rule birds seem ready to sit on any sort of eggs. Our domestic hen will hatch ducks, turkeys or pheasants as readily as her own chicks; in Sir John Sinclair's classical attempt to introduce the nightingale into Scotland the eggs of this bird were hatched by Robins; the Hon. Daines Barrington reared linnets under Skylarks, Woodlarks and Titlarks; Starlings have been known to sit on and hatch bantams' eggs. Professor Newton, however, suggested that while some species of birds are thus easily deceived there may be others which are not. And it would be only in the nests of the latter that we should expect to find the Cuckoos' eggs approximating closely to the others. This would explain the numerous exceptions. But to test the view thoroughly we should require to have figures showing the relative frequency of the resemblance in the case of a number of different species of small birds. There is some evidence that the Reed Warbler is one of the objectors, but in the one case in which we have seen—in a museum—a Cuckoo's egg in the nest of this bird it was *very different* in size and markings. We suggest, however, that those Cuckoos which habitually placed their eggs in the nests of the easily deceived Robin and Hedge Sparrow would succeed so much better in the struggle for life than those which went with their not yet perfectly matching eggs to the nests of the more fastidious birds, that the latter would, according to the principles of natural selection, be weeded out.

Let us suppose, however, that the Cuckoo species is divided into races laying eggs of different colours, blue, dark grey speckled, blue speckled with brown, and so on. Should we not expect this race segregation as regards eggs would be accompanied by some differences in plumage and other characters? In the case of the domestic fowl we know that differences in the eggs are associated with variations in other characters. No case of two varieties laying different eggs without variation in plumage, and so on, can be brought forward. But no such racial differences can be pointed out in the Cuckoo.

And then we must remember that the male Cuckoo has his part to play in the matter. Is there any evidence that a male hatched in a Wagtail's nest, for example, usually seeks for its mate a female laying Wagtail-like eggs, or reasons why it should? What marks are there by which he could recognise the right female, supposing his tastes were orthodox? And if he did not choose the right partner would not the variation in the direction of laying Wagtail-Cuckoo eggs be swamped? Nay, further, might it not happen that if a Hedge-Sparrow-Cuckoo mated with a male hatched from a Robin-Cuckoo egg, the blue-egg layers among the offspring would inherit the instinct of placing their eggs in Robins' nests, and those which laid eggs like the Robin's the instinct of choosing the Hedge Sparrow as foster-parent?

And then must we not also consider the question of the evolution of what we may call the receptivity in the foster-parent? Professor Newton points out that this *varies* in different species, and thus it becomes a quality subject to the action of natural selection. In the beginning, again, it must have been variable among individuals of the same species. Some would receive the Cuckoos' eggs, and some would reject them. The latter would succeed best in rearing their own offspring, while those which reared young Cuckoos would leave no inheritors of their—from the Cuckoo's point of view—virtues. Thus the quality of receptivity could never be evolved on the lines of natural selection: those possessing it would be weeded out.

The evolution of the Cuckoo by natural selection, in fact, bristles with difficulties.

PREHISTORIC HEARTHS ON THE COAST OF SOUTH WALES.

By ARTHUR L. LEACH, F.G.S.

In 1906 Messrs T. C. Cantrill and O. T. Jones, of the Geological Survey, in drawing attention* to certain heaps of burnt stones, which they had discovered chiefly in the inland parts of Pembrokeshire and Carmarthenshire, suggested that they were the sites of prehistoric—probably Neolithic—cooking-places, and that the stones had been used as "pot-boilers" in some primitive mode of cookery. Since that date many more have been detected by various observers, and in a recent paper by the same authors, on "Prehistoric Cooking-places in South Wales" (*Archaeologia Cambrensis*, June, 1911), two hundred and seventy-one hearths are enumerated, and their probable age and origin are more fully discussed. With the exception of a group of three such hearths upon the Pembrokeshire coast described† by me (see Figure 473) and included in the above list, none of the recorded examples are situated immediately on the coast-line. During the month of August, 1911, I noted three additional hearths near the shore: they present, particularly in one case, as will be seen, some features of unusual interest which may help to throw light on the problem of the age of these curious mounds of burnt stones.

From a photograph *by R. H. Chandler.*

FIGURE 473. Hearth above the shore at Swanlake, Pembrokeshire, in which a flint flake was found amidst the burnt stones. The photograph shews also the channel of a small stream immediately beside the hearth.

In the chalk districts of south-eastern England the burnt flints, which occur commonly on the North and South Downs in the vicinity of prehistoric settlements, are known familiarly as "pot-boilers" and easily may be recognised by the innumerable tiny cracks forming a close network on their calcined surfaces. These cracks are due to repeated expansion and rapid contraction of the stone when it was used as a "pot-boiler" by being first heated strongly and then dropped into a cooking-pot containing water. "Pot-boilers" may be found scattered over the ground in some localities in association with flint cores and flakes, while not infrequently small cooking-pits or fireplaces are discovered filled with broken pottery, fragments of bones, charcoal and calcined flints. The Welsh mounds of burnt stones present some features of peculiar interest and, unlike the Downland cooking-places, which sometimes may be definitely assigned to the Neolithic or to the Bronze age, the period of their use remains still a matter of speculation.

In outward appearance a hearth is usually a low mound, overgrown by grass or gorse, situated close beside a spring or small stream, and rising but little above the general level of the ground. It may be quite irregular in outline or roughly circular and from six feet to fifty feet in diameter; occasionally it assumes a crescentic or horseshoe form with the concavity towards the stream. On digging into the mound (or observing

From a photograph *by R. H. Chandler.*

FIGURE 474. Hearth at Marros, Carmarthenshire.

The burnt stones are overlapped on each side and almost covered by the storm-beach pebbles which have been thrown up since the occupation of the cooking place.

* "Note on the Discovery of Prehistoric Hearths in South Wales." *Arch. Camb.*, 1906, page 17.

† "Note on the Discovery of Prehistoric Hearths at Swanlake." *Arch. Camb.*, 1909, page 243.

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the sections caused by the partial destruction of the coast-line hearths by the sea) it is found to consist of a layer, not more than three or four feet thick and frequently much less, of very angular stones packed in dark soil mixed with much charcoal and charcoal-dust. The stones, rarely larger than pieces broken for road metal, are burnt black, yellow or bright brick-red in colour, and obviously are fragments of larger blocks of sandstone, quartzite or other hard rocks which have split up after frequent heating and sudden cooling. Many of the mounds have been almost destroyed under the plough, others are mere lines of "pot-boilers," while others still contain several tons of burnt stones.

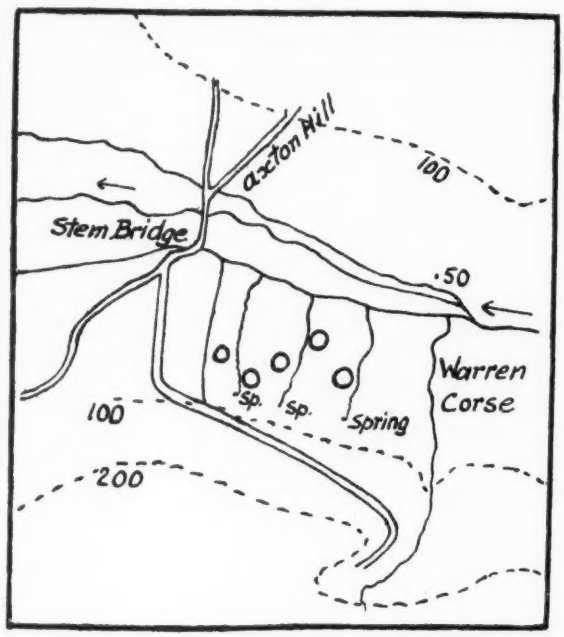

FIGURE 475. A group of five hearths (indicated by the small circles) on Warren Corse, near Castlemartin, Pembrokeshire.

Of the six hearths found by me near the shore, the three at Swanlake and one described below, are all good examples and quite typical, but the last is of more than ordinary interest.

The hearth at Marros (see Figures 474, 476, and 477) lies twenty-five yards from an excellent spring which issues about twenty or twenty-five feet above the shore. A streamlet trickles past the hearth and now oozes away below the storm-beach which, since the occupation of the cooking-place, has been banked fully twenty feet above the shore by winter storms and has not only blocked the course of the little stream but has almost completely buried the mound. On the seaward side, however, where a recent storm has torn away a large segment of the hearth, a clear section is exposed down to the underlying yellow drift clay. The true hearth consists of a layer three feet thick of rather small angular pieces of sandstone, grit, and quartzite, (all from the local rocks), burnt and discoloured by fire and closely packed in dusty charcoal. It is noteworthy that none of the burnt stones seem to be fragments of beach pebbles, although the whole mound is now surrounded and covered by such pebbles. A quite exceptional feature appears on the seaward side where there is a row, six feet long, of large blocks of sandstone: this may be a remnant of a low retaining wall.

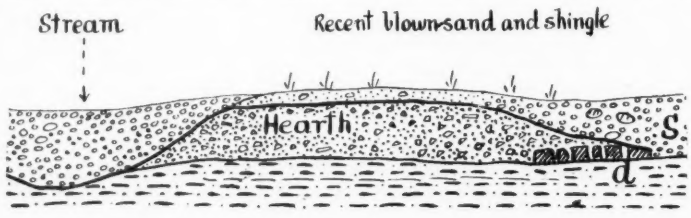

FIGURE 476. Diagrammatic section of a prehistoric cooking place at Marros, Carmarthenshire.
(d) = Yellow stony clay. *(s)* = Storm beach.

Of relics, which might throw light on the period when this cooking place was used, it may be said, in the words of Dr. Johnson, that "the negative catalogue is very copious," for no traces of pottery or other cooking vessels, bones, shells, stone or other implements, could be found. The remark is equally true (with two possible exceptions) of all the hearths yet examined but very few have yet been carefully searched.

The exceptions are at Swanlake, where from each of two of the hearths I obtained a flint flake amongst the burnt stones and charcoal. No other clues to the age of the hearths have as yet been found actually in any of them, but Messrs. Cantrill and Jones picked up several flakes on a mound broken up by the plough, and they record the occurrence of flakes and a core near a spring adjoining a hearth at Westhook. During the year 1911 I found flint flakes and cores in the vicinity of other hearths:

(1) Near the spring at Marros.
(2) In rainwash near a hearth at Manorbier.
(3) In rainwash near a hearth at Cwm Mawr, Newgale.
(4) In rainwash, three feet deep, a few yards from the hearths at Swanlake.
(5) On a hearth on Warren Corse.

It is not probable that in all these instances the association between the hearths and the flint flakes is accidental; least of all at Swanlake, where flakes occur not only (1) in the hearths and (2) in rainwash very close to them, but also (3) on a chipping-floor on the cliff-top above the hearths. It seems fair to infer here a connection between the cooking-places and the presumably Neolithic chipping-floor.

Usually the mounds occur singly; but a few groups of two or three have been noted. The largest number yet observed in close association is a group

of five in Warren Corse (see Figure 475), four miles south-west of Pembroke. From Axton Hill large black patches were observed on the bright red soil of a newly-ploughed field, and on investigation these proved to be typical hearths, situated immediately beside the streamlets (see Figure 475). A flint scraper of a peculiar steep-nosed form was picked up amidst the burnt stones disturbed by the plough.

To summarize the salient features of these hearths:—

(1) They are situated almost invariably beside springs or streams.

(2) They consist entirely of burnt stones.

(3) They have yielded neither pottery, bones, shells, nor any implements of metal.

(4) In two, possibly three, cases, flint chips have been found in them, and in several instances flint cores and flakes have been obtained in their vicinity, deeply buried in an old rainwash deposit.

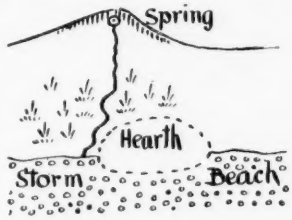

FIGURE 477.

Diagrammatic plan of the prehistoric cooking place at Marros, of which a section is given (Figure 476).

The evidence, therefore, points to their use at an early date by people unacquainted with metals: that is, to some part of the Neolithic age.

This view receives support from the relation of these coastal hearths to the present shore line. At Swanlake the low cliff upon which they stand is gradually receding and large segments of the mounds have been destroyed by the sea; at Marros an enormous accumulation of pebbles has been built by the waves; yet, although the cooking-place is almost buried by these pebbles, not one seems to have been used as a "pot-boiler." It is clear that these hearths were in use before the coast-line had assumed its present form and while the land extended considerably further on what is now their seaward side. At a date so recent, possibly, as the Neolithic Age much of the shoreward part of Carmarthen Bay was a marshy woodland, connected with the fringe of land which has been traced by its "submerged forest" round most of the English and Welsh coasts. On the shore below the hearth at Marros the stumps of many large trees remain *in situ*, rooted in the stony clay which underlies the beach. The storm-beach has accumulated since the submergence of these trees and since the construction of the hearth. It seems probable that the prehistoric cooking-place was occupied while the ancient woodland grew between it and the sea. Such evidence as can be gathered from the hearths and their surroundings certainly favours their association with a period not later than the Neolithic age.

The particular method of cooking employed by the hearth-builders needs explanation. By modern studies of semi-civilised races various methods of boiling, baking, roasting, and grilling have been observed: down to the present day some Australian aborigines cook meat upon hot stones or ashes or upon a rough grill made of crossed sticks, or boil it in a bark trough or in a large shell by using "pot-boilers." In other cases the food is boiled or baked in small pits, made watertight by a lining of clay or skins. Some of these methods were probably in use in prehistoric Britain before skill had been attained in the manufacture of good fire-resisting pottery. In Ireland, heaps of burnt stones situated near springs have long been regarded as prehistoric cooking places, and in one case, cited by Messrs. Cantrell and Jones, there was found immediately beside the mound and level with the stream a wooden trough in which the food was probably cooked, the water being heated by "pot-boilers," which were used over and over again until they fell to pieces and fresh stones were selected. A mass of burnt stones and charcoal thus accumulated upon the hearth beside the cooking-trough.

That the South Wales mounds were cooking-places appears beyond reasonable doubt, and some of them were probably associated with cooking-troughs or hollows, but no traces of actual cooking-vessels have yet been found, and it may be that some of them were used chiefly for simpler methods of roasting or grilling by hot stones.

THE ROYAL INSTITUTION.

GENERAL MEETING.—A General Meeting of the Members of the Royal Institution was held on the afternoon of November 4th, Sir James Crichton-Browne, Treasurer and Vice-President, in the chair. Dr. J. H. McBride and Miss Jane Worth were elected members.

The Honorary Secretary reported the decease of Professor Henri Poincaré, an Honorary Member of the Institution, and a resolution of condolence with the family was passed.

CHRISTMAS LECTURES FOR CHILDREN.—We have been asked to announce that the eighty-seventh Christmas Course of Juvenile Lectures, founded at the Royal Institution in 1826 by Michael Faraday, will be delivered this year by Professor Sir James Dewar, LL.D., D.Sc., Ph.D., F.R.S., Fullerian Professor of Chemistry, his title being "Christmas Lecture Epilogues." The Lectures will be experimentally illustrated, and the subjects are as follows:—Alchemy, Saturday, December 28th, 1912; Atoms, December 31st; Light, January 2nd, 1913; Clouds, January 4th; Meteorites, January 7th; Frozen Worlds, January 9th.

The Royal Institution is in Albermarle Street, and the lectures will be given at 3 o'clock in the afternoon.

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NOTES ON THE ESSENTIAL OILS, INCLUDING AN ACCOUNT OF THE MATERIALS AND METHODS OF PERFUMERY.

By H. F. SLACK, Pharmacist.

THE subject matter embraced by the above title covers one of the most extensive fields of modern industrial organic chemistry, and therefore it has not been attempted in this article to give more than a rudimentary outline of the numerous branches and processes involved, each of which is individually of sufficient importance and magnitude to merit the dedication of an entire volume.

It has been endeavoured, however, to give a brief resumé of the modes of preparation; the composition, and examination of the volatile oils; to name and describe certain animal and artificial substances employed in the manufacture of perfumes, and to conclude with a short survey of the methods adopted in manipulating to the best advantage numerous natural and synthetic products used for producing the exquisite and subtle combinations of odours possessed by many of our modern spirituous essences.

Bearing in mind that the spices and aromatics have been from time immemorial, and are at present, a prominent factor in the world's commerce, it may not seem out of place to commence with a brief retrospect of the history of the essential oils, which may be, for practical purposes, broadly defined as oily, odoriferous bodies, volatile without decomposition, obtained from vegetable sources.

In this, as in most researches into ancient historic documents, investigation as to the source and distribution of these materials leads to Central Asia, where the spices found use not only on account of their agreeable odour and taste, but also as articles of exchange, and in religious and sacrificial ceremonies.

Whether a beginning of the preparation of the aromatic principles of plants, our modern volatile oils, was made previous to early Hindoo or Egyptian civilization, does not become apparent, even from the oldest documents; but we know that the Egyptians, whose history dates back as far as 4000 B.C., were acquainted with common metals, furnaces and distilling apparatus.

The study of natural sciences was carried on to some extent by the Greeks and Romans, the insight gained by the latter people into the character of drugs being demonstrated by the writings of Dioscorides, Pliny and Galen. A decided advance in scientific research was achieved by the Arabs, who fostered the process of distillation already described by Synesios and Zosimos, two Greek scholars of the fourth century. The decay of Arabian science was brought about, however, by their ardent desire to convert the baser metals into gold, and it was not until the advent of Paracelsus, who taught that the object of chemistry was to make remedies and not gold, that a marked development of the art of distillation and a clearer conception of the nature and composition of the essential oils were acquired.

Information as to the subsequent progress of the oil-distilling industry is available in the form of several lists of current drugs and spices in the city of Frankfort-on-the-Main, which were published during the years 1450, 1580 and 1587, and in a book entitled the " Destillirbuch," written by Brunschwig and published during the sixteenth century.

Although in the year 1730 about one hundred and twenty volatile oils were known and placed in general use and commerce, it was during the eighteenth century that a great stimulus to the art of perfumery was initiated by the successful combination of several odours in attempts to produce agreeably fragrant mixtures. An example of such a preparation is afforded by the Eau-de-Cologne of Johann Maria Farina, introduced in the year 1725, which, in its modified form, is in great demand at the present time. The consequent greatly increased production of the oils, and constant growth of the industry in the South of France, caused more attention to be devoted to the constitution of the valuable primary odoriferous bodies which are applied in the perfumery art. Classical researches in this direction were conducted in Germany and France, but, as a record of these would be of a purely chemical nature, we will apply ourselves to a study of the isolation of the volatile oils, and incidentally, by the aid of a few diagrams, endeavour to trace the evolution of the modern steam distillation apparatus from the almost inconceivable crudities tolerated in the appliances used by the ancients and during the Middle Ages. The primitive distillation vessels employed in the production of the essential oils are described as open kettles heated by a direct fire, and having, as a condenser, a layer of wool supported by pieces of wood placed across the opening (Figure 478).

The form of subsequent stills appears to have been based upon the outline of certain animals; for instance, the goose provided an idea for a retort, as illustrated by Figure 479.

A further step was then taken by employing the advantages of the water and sand baths to replace the discovered deficiencies of the naked fire previously used, and by adopting various methods of condensing, —by means of air and water—the vapours evolved during the distillation.

An inefficient type of air condenser, used as early as the fifteenth century and known as the " Rosenhut," is depicted in Figure 480.

The use of water as a cooling agent now came to have general application, and simultaneously sprang up the idea of the "Worm" condenser, one of the earliest forms of which is illustrated by Figure 482. The barrel was filled with cold water, which effected the cooling of the vapours as they passed through the undulating pipe. Special varieties of stills came into use for the manipulation of large quantities of materials; one of the most frequently employed and interesting of these, fitted up in the "galley furnace" style, is seen in Figure 481. These early processes, consisting of introducing the plant along with water into the apparatus, usually heated by a direct fire, display two disadvantages. Firstly, the plant itself may be easily burnt, with the result that the oil acquires a disagreeable empyreumatic odour, and secondly, a very careful adjustment of the amount of water is necessary, seeing that too little renders the oil-containing material more liable to be scorched, while an excess results in partial solution of the small amount of the distilled oil collected along with the relatively large volume of condensed water in the receiver.

FIGURE 478.
A primitive Condenser made of a layer of wool.

FIGURE 479.
An early form of Still based on the outline of a goose.

This latter dilute aqueous solution of the oil represents a considerable loss, as it can only be employed as an aromatic water.

To obviate these disadvantages, the simplest modification consists in suspending the plant substance in copper cages, which do not touch the bottom of the still.

Water is run in, and when sufficient heat is applied, the steam produced by the boiling water carries over with it the essential oil. This process constitutes the basis of the English method (see Figure 483), and as several of the oils produced in this country are the finest obtainable, the (modified) method must necessarily be a good one.

In general, however, the process of steam distillation possesses many advantages, and constitutes the means employed in the large modern German and French stills, capable of holding eight thousand to sixteen thousand gallons. The *modus operandi* is as follows:—

The charge of material in a suitable state of comminution is placed upon a perforated false bottom; steam, which is admitted under pressure from a pipe coiled beneath the plants, carries over the essential oil through an outlet at the top of the still, into efficient condensers. A spiral of steam pipes lines the interior of the plant-containing portion, and the whole mass of material is continually turned over by means of mechanical stirrers. The mixture of oil and water in the receiver separates: the oil, having a specific gravity lower than that of the water, floats on the surface of the latter liquid, and is removed by suitable means.

The phenomenon of the high boiling oil distilling with the steam finds explanation in the fact that the atmospheric pressure, acting upon the mixture, is naturally divided between the steam and the other substances, so that the partial pressure upon the latter is accordingly less than the atmospheric pressure. In consequence, the volatility is increased. The distillation with steam is, therefore, to be regarded as a special case of distillation in a partial vacuum.

Two different types of steam distillation apparatus are shown in Figures 483 and 484. Figure 483 indicates the variety usually employed in this country for manipulating small quantities of material, the plants being placed in the upper globular portion, while the steam is generated in the lower reservoir. Figure 484 illustrates a great still of fifty thousand gallons capacity, used in the largest and most up-to-date essential oil distillery in the world, that of Messrs. Schimmel & Co., Miltitz bei Leipsig. To this firm I offer my heartiest thanks for their courtesy in allowing me to reproduce from "Die Aetherischen Ole" (Gildemeister & Hoffmann) Figure 484 as well as 485, which depicts a room in their distillery. Although the majority of essential oils are obtained by a process of distillation, great attention has to be paid to the properties of the oils, and to their individual constituents, in deciding what treatment is most advantageous. It is not possible here to do more than briefly refer to the other methods of isolation, which may be grouped under two headings, *viz.*:—Expression and Extraction.

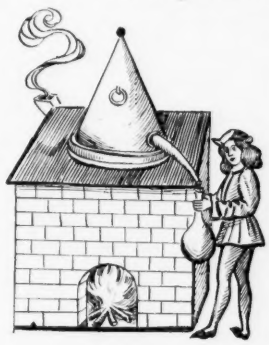


FIGURE 480.
The "Rosenhut" air Condenser.

Of the many and various operations employed and involved in conducting the former, the Sponge or Spunga method is the one most generally used, being particularly adapted to obtaining the oils of the Citrus family, *e.g.*, orange, lemon, and bergamot.

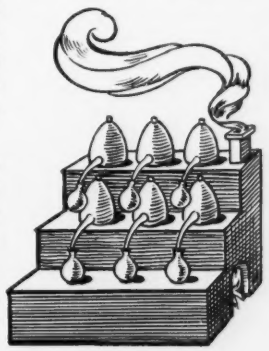


FIGURE 481.
A Still of the "Galley Furnace" type.

The pieces of the peel of

these fruits are pressed against a sponge, which breaks the oil vessels and extracts the liquid, the latter being periodically squeezed out. This is the process largely made use of in Sicily for obtaining oil of lemon, and the expressed oil, so obtained, is purified by filtration.

The second method—"extraction"—consists in removing the oil contained in the particular material by means of a solvent (chloroform, carbon bisulphide, methyl chloride, and so on), which, being usually volatile, is afterwards recovered by distillation, the remaining oil being freed from the resinous and colouring matter, also dissolved by the above-mentioned liquids, either by rectification under reduced pressure or distillation in steam. A further method of removing the odorous constituents of plants is performed by treatment with a non-volatile substance (lard or other fat); this method will be referred to later when we come to consider the preparation of perfumes. The distribution of essential oil in plants may be either general or local, the pine affording an example of the former, while in the rose it is confined to the leaves of the flower, in the cinnamon to the bark, and in the orange to the pericarp of the fruit.

The volatile oils, which in many cases are katabolically-produced secretion or excretion products, are found either in closed cells, or in special reservoirs in the plant tissues. The origin of the latter oil ducts or vessels may be either lysigenous or schizogenous, these botanical terms expressing respectively the absorption or separation of series of cells to form more or less definite cavities or passages. Figure 487 illustrates a lysigenous cavity in the pericarp of the orange, with a drop of ethereal oil, and Figure 486 a schizogenously-formed oleo-resin duct of a species of *Pinus*, with its layer of thin-walled parenchymatous epithelial cells.

In the hop the oil is found in dermal glands of capitate and peltate form, while in the Umbelliferae it is stored in tube-like structures, known as vittae,

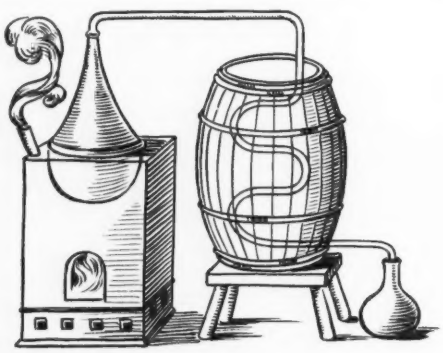


FIGURE 482.—An early form of the worm Condenser.

chiefly in the fruits, the latter usually possessing two such vessels on the commisural and four on the other surface of each mericarp, although in the anise many more (usually twenty to thirty) vittae are discernable in either half of the cremocarp.

Although most essential oils pre-exist in the plant tissues, many owe their formation to the hydrolysis of substances of a glucosidal nature, brought about by ferments.

Examples of this chemical action are afforded by the production of the volatile oils of black mustard (seed) and bitter almond (seed). In the former the enzyme is a substance called myrosin, while the glucoside is represented by sinigrin; in the latter emulsin and amygdalin illustrate the same classes of

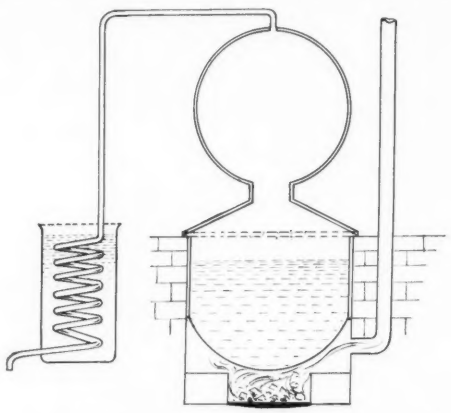


FIGURE 483. Steam distillation apparatus used in England for small quantities.

substances. No action takes place in the seeds of these plants on account of their active principles being situated in different cells; but when these cells are ruptured in the presence of water the reactions indicated by the following equations occur:—

$$C_{10}H_{16}KNS_2O_9 + H_2O = C_3H_5CSN + C_6H_{12}O_6 + KHSO_4$$
Sinigrin = Allyl Isothiocyanate + Glucose + Potassium Hydrogen Sulphate

$$C_{20}H_{27}NO_{11} + 2H_2O = 2C_6H_{12}O_6 + C_6H_5 \cdot CHO + HCN$$
Amygdalin = Benzaldehyde + Hydrocyanic Acid.

In the latter case the poisonous hydrocyanic acid has to be removed by suitable treatment before the oil is safe for use as a flavouring agent, when it will consist of practically pure benzaldehyde. When the oils of black mustard and bitter almond are manufactured in large quantities, the seeds are first subjected to a process of maceration with water, to allow the formation of characteristic odorous principles, indicated in the above equations.

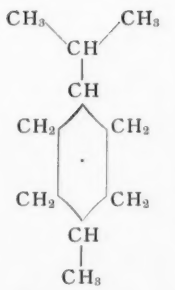
We will now divert our attention from the production to a very brief review of the more common constituents of the essential oils.

These may be roughly classified under the following heads:—(1) The Terpenes, (2) Alcohols and esters, (3) Phenols and their derivatives, and (4) Aldehydes and ketones.

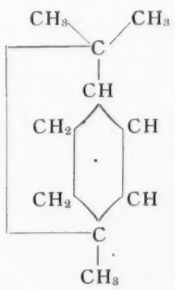
It is proposed to outline the main properties of these great groups of organic compounds, and to illustrate, by the aid of Table 50, their occurrence in a few well-known volatile oils.

(1) The hydrocarbons, known as the terpenes, along with their derivatives, constitute the most

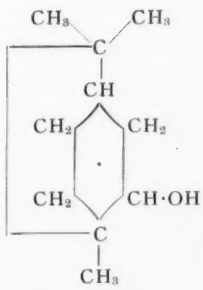
widely distributed compounds found in the essential oils, and form the subject of extended scientific research. The hydrocarbons possess the general molecular formula $C_{10}H_{16}$, and are often accompanied in nature by other unsaturated ones of higher molecular weight, having the same empirical formula, C_5H_8. Those expressed by $C_{15}H_{24}$ have been named sesquiterpenes, whilst the more complex ones still have been termed polyterpenes $(C_5H_8)_n$. Although the constitution of the terpenes has not been definitely ascertained, they are known to be derivatives of benzene, and the accompanying formulae are those generally accepted as expressing the relations of the hydrocarbon camphene, the alcohol borneol, and the ketone camphor to hexahydrocymene, the hexahydrogen derivative of methylisopropyl benzene.



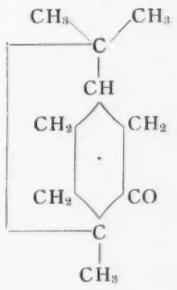
Hexahydrocymene.



Camphene.



Borneol.



Camphor (Bredt).

(2) Although many naturally occurring alcohols (*e.g.*, borneol, terpineol, and so on) in essential oils are derivatives of the terpenes, it is convenient to mention them separately. They are usually associated in Nature with their esters (compounds of the alcohols with acids—in this case, of the fatty series); for instance, linalol ($C_{10}H_{18}O$) is accompanied by linalyl acetate ($C_{10}H_{17}O{\cdot}COCH_3$) in lavender oil, and geraniol ($C_{10}H_{18}O$) by geranyl

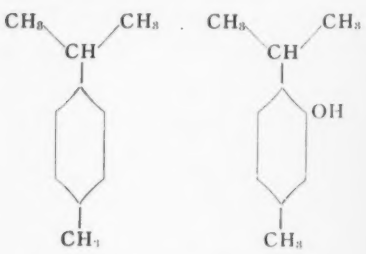
Common Name of the Oil.	Source.	Natural Order.	Chief Constituents.
Turpentine ...	*Pinus Australis* and *Pinus taeda*	Pinaceae ...	Pinene, $C_{10}H_{16}$ / Dipentene, $C_{10}H_{16}$ (T).
Juniper	*Juniperus communis* ...	Pinaceae ...	Pinene, cadinine ($C_{15}H_{24}$) (S), and "juniper camphor" (formula unknown).
Nutmeg ...	*Myristica fragrans* ...	Myristicaceae	Terpenes.
Cassia	*Cinnamomum cassia* ...	Laurineae ...	Cinnamic aldehyde.
Cinnamon ...	*Cinnamomum xylanicum*	Laurineae ...	
Camphor ...	*Cinnamomum camphora*	Laurineae ...	Camphor (K), terpineol (A), eugenol (P).
Mustard ...	*Brassica nigra*	Cruciferae ...	Allyl isothiocyanate (En).
Rose	*Rosa damascena* ...	Rosaceae ...	Geraniol (G), Citronellol (G), esters and a solid stearoptene.
Bitter almond ...	*Prunus amygdalus*, var. *amara*	Rosaceae ...	Benzaldehyde and (unless freed from) hydrocyanic acid.
Lemon	*Citrus medica*	Rutaceae ...	Terpenes, citral (A) $C_{10}H_{16}O$.
Orange	*Citrus aurantium* ...	Rutaceae ...	Limonene $C_{10}H_{16}$ (T), and aldehydes.
Bergamot ...	*Citrus bergamia* ...	Rutaceae ...	Limonene $C_{10}H_{16}$ (T), linalol $C_{10}H_{18}O$ (G), linalyl acetate $C_{12}H_{20}O_2$ (E).
Rosemary ...	*Rosmarinus officinalis*	Labiateae ...	Terpenes, borneol $C_{10}H_{18}O$ (A), camphor (K) $C_{10}H_{16}O$.
Lavender ...	*Lavandula vera* ...	Labiateae ...	Linalol (G) and esters (acetate).
Peppermint ...	*Mentha piperita* ...	Labiateae ...	Menthol ($C_{10}H_{20}O$) (A), menthyl acetate ($C_{12}H_{22}O_2$) (E).
Eucalyptus ...	*Eucalyptus globulus* ...	Myrtaceae ...	Cineol ($C_{10}H_{18}O$) (A), and phellandrene ($C_{10}H_{16}$) (T).
Bay	*Pimenta acris*	Myrtaceae ...	Eugenol (P), and olefinic terpenes.
Cloves	*Eugenia caryophyllata*	Myrtaceae ...	Eugenol (P), and caryophylline $C_{15}H_{24}$ (S).

TABLE 50.

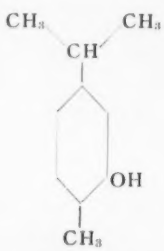
tiglinate $CH_3 \cdot CH : C\langle^{CH_3}_{COO \cdot C_{10}H_{17}}$ in oil of geranium.

(3) Of frequent occurrence in volatile oils are the following phenols:—eugenol $C_{10}H_{12}O_2$, thymol and carvacrol.

The relations of the latter two to each other and to cymene (p-methylisopropyl benzene) are expressed by the following formulae:—



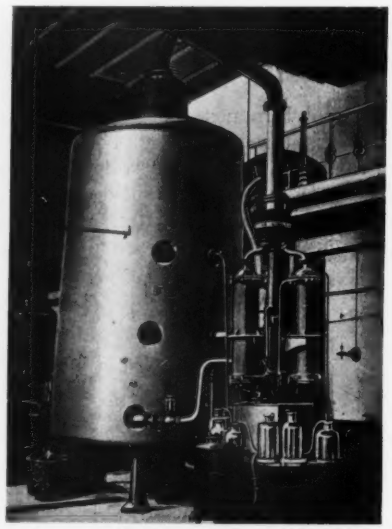
Cymene. Thymol.



Carvacrol.

(4) Of this class the following aldehydes constitute a large percentage of many volatile oils:—cinnamic aldehyde, $C_6H_5(CH:CH \cdot CHO)$, benzaldehyde, $C_6H_5 \cdot CHO$, and anise aldehyde, (aubépine) $C_6H_4(OCH_3)(CHO)$, while the ketones are represented by pulegone ($C_{10}H_{16}O$) in the oil of pennyroyal. Table 50 (see page 457) will show how the constituents of the essential oils remain fairly constant throughout each natural order, and will indicate the occurrence of the various chemical substances above mentioned, in their respective oils. The letters in brackets after the names of the constituents refer to the particular groups of chemical compounds to which the latter belong.

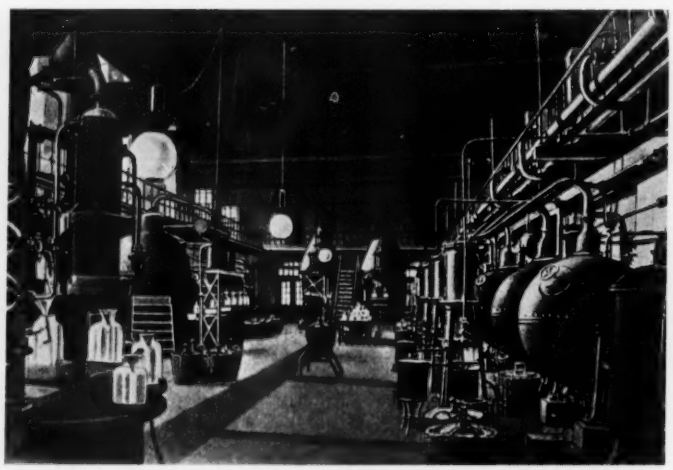
T—Terpenes.
S—Sesquiterpenes.
A—Alcohol derivatives of terpenes.
Al—Aldehydes.
K—Ketone derivatives of the terpenes.
En—Produced by enzyme action.
D—Aldehyde derivatives of the terpenes.
E—Esters.
G—Alcohols of the Geraniol series.



By the courtesy of *Messrs. Schimmel & Co.*

FIGURE 484.

A huge still of fifty thousand gallons capacity.



By the courtesy of *Messrs. Schimmel & Co.*

FIGURE 485.

A room in the Distillery of Messrs. Schimmel & Co., the largest in the world.

When we consider the high prices reached by some of the essential oils, Otto de Rose at the present time almost attaining seventy shillings per ounce, it is evident that they offer great temptation to the manufacturers and dealers to impoverish them by adulteration or partial removal of valuable odoriferous constituents. The usual adulterants are alcohol, terpenes, fixed oils and resins. The presence or absence of all of these substances may usually be ascertained by the odour of the oils and by the determination of their physical and chemical constants, the figures so obtained being compared with those generally accepted for a genuine oil.

The methods of examination may be divided into the following classes:—

(1) Physical.
(2) Chemical.

Concerning the former, the routine operations consist of the determination of the specific gravity and other constants, such as the optical rotation, refractive index, and solubility in a given solvent. The congealing (or melting) point, residue on evaporation, and the behaviour of the oil on fractional distillation also offer valuable clues as to any sophistication.

The specific gravity is usually determined at 15·5° C in a small apparatus known as the Sprengel tube.

This tared tube (see Figure 490) is filled up to the mark on the larger limb at the specified temperature, weighed, and the specific gravity calculated by deducting the weight of the tube and dividing the

remainder by the weight of an equal volume of water at the same temperature.

The optical rotation is usually determined by means of the modern half-shadow polariscope in a tube one hundred millimetres long, while the refractive index is found preferably by means of an Abbe refractometer, fitted with a constant temperature arrangement.

Fractional distillation is conducted in a Ladenburg flask, illustrated by Figure 488, and the solubility determination in a stoppered and graduated glass cylinder, having a capacity of ten cubic centimetres.

The chemical quantitative methods of testing applied to the analysis of essential oils are exceedingly numerous, so that only a few of the most typical and generally employed will be referred to.

These consist of the estimation of esters, free alcohols, and other well-defined constituents, such as phenols and aldehydes.

The principle of the determination of esters depends upon their being hydrolysed by boiling with alcoholic potash, according to the equation :—

$$R\bar{A} + KOH = R \cdot OH + K\bar{A}$$

Where R is the alkyl and $\bar{A}$ the acid radicle.

The quantitative analysis of oils containing free alcohols consists of converting the latter into their acetyl derivatives by boiling with acetic anhydride, and saponifying the separated product by boiling with a standard solution of alcoholic alkali as represented by the above equation. Many constituents of the volatile oils, which are practically quite insoluble in water, readily form soluble compounds with solutions of inorganic bodies. Aldehydes, for example, are dissolved by sodium hydrogen sulphite, and phenols by potassium hydroxide solution. The residual oil, non-aldehyde or non-phenol, as the case may be, is left floating upon the aqueous solution, and may be estimated by bringing it into the graduated neck of the special flash used for this purpose, by adding more of the aqueous solution, or of water, and reading the volume of the oil there indicated. One of these so-called "Cassia" flasks, usually made of two hundred cubic centimetres capacity, with the neck graduated from 0·1 to ten cubic centimetres, is seen in Figure 489.

As the perfume industry is dependent upon products of the animal as well as the plant world, we will now, therefore, consider the sources and properties of a few animal and artificial substances used in the art.

Of the former articles, musk ranks first in importance, but mention will also be made of civet and ambergris. These materials are, properly speaking, not perfumes, but, by their special characteristics, *e.g.*, their persistent but not sweet odour, serve to "fix," as it is technically termed, other odours which are too delicate and fleeting. Indeed, in many cases these products possess a very disagreeable smell, as they are frequently in a state of partial decomposition.

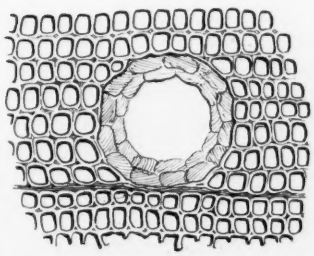


FIGURE 486.
Oleo-resin duct of *Pinus*.

Musk is a very valuable substance obtained from the preputial follicles of the musk deer (*Moschus moschifera*), a graceful animal inhabiting Central Asia. The males bear a small sac, containing the soft, unctuous and granular secretion which possesses a penetrating ammoniacal odour. Civet, another of the above-mentioned animal products, is obtained from the perineal glands of the civet cat (*Viverra civetta*) and other species of Viverra (Natural Order Carnivora). It is imported from Africa and the West Indies. The animal is a domestic one and the natives extract, usually twice a week, the secretion from the glands, and place it in the horns of buffaloes, in which form it is usually seen in commerce. Its strong characteristic odour somewhat resembles that of musk, and in a state of great dilution the article is advantageously employed to modify other essences and perfumes. The remaining substance of animal origin, Ambergris, concerning which many theories are afloat, is a product of the sperm whale (*Physeter macrocephalus*), and is believed to be the indurated faeces, probably somewhat altered by disease. It is an opaque, greyish, striated solid of irregular shape and friable nature, found floating in large masses at various times on the surface of the sea near Madagascar and Japan. With increased knowledge and insight into the constituents of odorous plants it has become possible to isolate numerous important active ingredients; and the science of organic chemistry in one of its important branches has been and is directed to producing naturally occurring plant and animal principles by synthetical methods. The more important isolated odorous constituents of plants include vanillin, from the vanilla pod, and coumarin, from the tonquin bean. Both these principles are now produced by synthetical methods: vanillin ($C_6H_3(CHO)(OCH_3)(OH)$), from the glucoside coniferin ($C_{16}H_{22}O_8 + 2H_2O$), and coumarin ($C_9H_6O_2$), the δ-lactone of coumarinic acid, from salicylic aldehyde $C_6H_4(OH)(CHO)$.

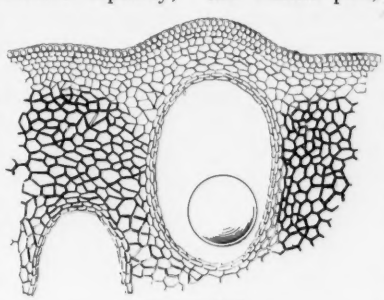


FIGURE 487.
Lysigenous cavity in the pericarp of the orange, containing a drop of ethereal oil.

Chemical compounds without number are now prepared for use in the manufacture of perfumes; but only those of definite constitution will be mentioned.

XUM

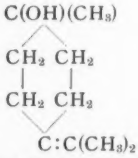
Heliotropin, $C_6H_3\begin{cases}CHO\\O\\O\end{cases}>CH_2$, possesses a powerful odour of Heliotrope, and is obtained by the oxidation of safrol, $C_{10}H_{10}O_2$; aubépine or anisic aldehyde, $C_6H_4(OCH_3)(CHO)$, reproduces the odour of May blossom; while "Ionone," an artificial violet perfume, for which a patent was taken out by Tiemann and Krüger, is prepared by a complicated series of reactions, by the condensation of citral with acetone.

Another product in extensive use is artificial musk, which fairly successfully imitates the odour of the natural article, although the chemistry of the latter is quite unknown.

The constitution of this substance, which has been the subject of numerous patents (Baur, and so on), varies, but the commercial article consists of a nitrated hydrocarbon, often butyl-xylyl-propyl-ketone

$$(C_3H_7\cdot CO\cdot C_6H_2\begin{cases}C_4H_9\\CH_3\\CH_3\end{cases}).$$

Other "synthetics" include compounds to represent natural Neroli, Rose, Hyacinth, and Lilac, the odour of the last named being closely imitated by the well-known body terpineol ($C_{10}H_{17}OH$). This chemical is inexpensive, and being unaffected by heat and alkalies, constitutes one of the most valuable perfumes for toilet soaps, although it is an ingredient of many of the best spirit perfumes on the market. The compound synthesised by Baeyer has the chemical formula:—



With regard to artificial rose oil, almost innumerable attempts have been made to imitate the "smoothness" and delicacy of the natural otto, but none have met with any great success. During the last year, however, great advances have been made in this direction by employing various substitution products of the alcohols of the geraniol series, and also by using phenyl-ethyl alcohol and its acetate. The natural constituents of Otto de Rose (see Table 50) are geraniol, citronellol, and so on, and mixtures of these naturally occurring principles constitute such preparations as "rhodinol," "roseol," and so on, which are supposed to approach in fragrance the aroma of the genuine oil.

In the foregoing paragraphs of this article we have become acquainted with the names and elementary properties of some of the more common constituents of the essences retailed in the shops.

We will now proceed to study the relations of the properties of these substances to each other, when used to imitate the odours of fresh flowers and in making ordinary "bouquet" perfumes. The solutions of numerous blended simple materials popularly known as "scents" or "perfumes" seem to have become invested with a certain air of sanctity, and it is hoped that the following outline of the methods employed in their manufacture will detract from them some small amount of the mystery they so obstinately retain.

It is not intended here, however, to in any measure deprecate the perfumer's art, which is one of the oldest known, and one from which chemistry has not removed much empiricism, but merely to remove from the average mind its ignorance of the nature of floral essences, probably caused by many mythical terms of description.

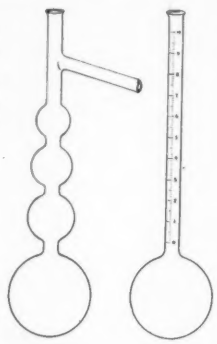


FIGURE 488. Ladenburg Flask.

FIGURE 489. Cassia flask.

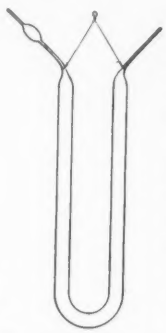


FIGURE 490. Sprengel tube.

In studying the art of the perfume industry, we can clearly and conveniently differentiate between the following classes of substances which are in constant use:—

(1) "Primary materials," which for our purpose include essential oils, artificial perfumes, various animal and plant substances, and pomades (to which reference will be made later). All these constitute the foundations of other intermediate preparations, which are included in the subsequent synopses (2, 3, and 4).

(2) The so-called tinctures, extraits, spirits and infusions.

(3) The specialities of different firms, "Concretes," and other substances, the formulae of which are not published; the last-named being, in many cases, liquids possessing the characteristic odours of defined flowers, and which are intended to be softened, fixed or otherwise modified with other materials.

(4) Compound preparations of more or less known or evident composition, or which can be imitated with a fair degree of accuracy. These could have been classed as "primary materials," except for the fact that they are of complex constitution, whereas the term is conveniently reserved for substances representing the properties of one particular plant. These complex compounds are blended mixtures of simple substances (essential oils, synthetics), which constitute useful bases of constant composition, and which have usually been at some previous time secret preparations similar to those included in (3). The pomades, *vide* (1), which have been mentioned on two previous occasions, are prepared in the south of France by two distinct methods, involving the removal of the odorous constituents of flowers by means of a mixture of fats, usually suet and lard, although olive oil and other fixed oils are sometimes used. The impregnation is either conducted by warming the mixture of flowers and fat in a steam-

jacketed pan to 60°C, or by *enfleurage*, a method of cold extraction, which consists of allowing the flowers to remain in contact with the fat for a certain time, and replacing them at intervals by fresh ones until the butyraceous mass has acquired a sufficiently strong characteristic odour.

The pomades obtainable include Jasmin, Rose, Tubereuse, Cassie, Violet, Orange flowers, and so on.

The substances, here designated as "primary materials," include many other products of the plant world, of which special mention has not been made; such are Tonquin beans (*Dypteryx odorata*), Vanilla pods (*Vanilla planifolia*), and Storax (*Liquidambar orientalis*).

Our second class of articles (2), comprises solutions of the "primary materials" in solvents. No absolutely definite rule stands for the exact application of the names there mentioned. Usually, and here, the tinctures mean solutions of vegetable substances, such as benzoin and the soluble constituents of Tonquin beans, in alcohol; the extraits refer to the alcoholic extracts of pomades; the spirits, to solutions of essential oils in alcohol; while the infusions represent liquids containing the soluble constituents of substances such as musk and ambergris, in special solvents.

With regard to the preparation of these semi-pharmaceutical products very little need be said.

The extraction of pomades is conducted on a large scale in France, by treating them in a specially designed emulsifying machine with alcohol, the process occupying about a week, while the operation for small quantities is carried out by macerating the fatty substance with the menstruum in closed vessels, with occasional stirring, for about a month.

The tinctures and spirits, usually being simple solutions of single substances, offer no difficulties in practice, but the successful manipulation of an infusion requires a little skill; that of musk, for instance, necessitating trituration or "rubbing down" of the material with hot water, and digestion for a fortnight with alcohol. Civet is usually mixed with powdered orris root, extracted in a similar manner, and finally improved by the addition of potassium carbonate.

The pomades and extraits, although far superior to alternative preparations as regards the delicacy of the odours they represent, are used only to a small extent in England, but in France they enjoy practically universal employment. In this country they are replaced by the so-called "concretes" [mentioned in (3)], which are essentially pomades without the fat. They are not designated in this treatise as "primary materials" because their methods of manufacture, although usually consisting of extracting the flowers with solvents, often petroleum ether, are guarded as trade secrets, and also because in many instances they are believed to consist, at least partially, of artificial substances.

These preparations are sent out under various copyright titles, in the form of concentrated semi-liquid products, and are met with representing the flowers already named in our consideration of the floral pomades.

It is quite possible to make an expensive and, in this respect, good perfume from a simple mixture of only essential oils dissolved in alcohol, but as preparations of this type are deficient in lasting power, various "fixers" are employed to impart the necessary stability. These fixing preparations include the already-mentioned infusions of animal products, and also many synthetic and proprietary articles possessing slow or slight volatility. Although it is impossible to teach, if such were even ever attempted, the art of perfumery in a book, it is quite easy to classify two distinct varieties of materials which give character and permanency to an essence, namely:—

(1) "Light" or delicate odours, *e.g.*, volatile oils and extraits of pomades respectively.

(2) "Fixatives," including infusions, tinctures of balsamic resins like benzoin and balsam of Peru (from *Myroxylon pareira*), and also many proprietary specialities, obtainable under various fantastic names.

It is in the judicious and minute attention to the blending of the articles of these two classes that the skill of the perfumer manifests itself; for it is only by the possession of an extremely well developed olfactory sense, and profound knowledge gained by protracted experience, that the odours of particular flowers can be successfully imitated, or the creation of novel and pleasing combinations can be accomplished. With even a small amount of practice it is possible, however, to acquire the art of such processes as the "softening" of one or the "enriching" of another odour; but it is by experience alone that one may become intimately acquainted with the affinity of odours and their incompatibility.

As the latter portion of this article only considers the preparation of the common handkerchief essences, it must not be supposed that this is the only or even the largest branch of the industry.

It is impossible in a small space to deal with the composition of perfumed waters (Lavender, Aqua Mellis, and so on), Eau de Cologne, powder and solid perfumes, or even to review the widely different methods adopted for perfuming toilet soaps and other preparations, such as hair lotions, cosmetics, and dentrifices.

It is hoped, however, that the original object has at least been partially accomplished: that of describing the sources, modes of preparation, and properties of a few of the chief substances employed in perfumery; of indicating the methods of manipulation involved in producing the spirituous essences familiar to us all, contained in their attractive cut glass bottles, artistically decorated with smart labels and the inevitable ribbon; and of demonstrating how science has improved upon the ancient methods of extracting the various odoriferous bodies, and has presented an important and continually increasing industry with ingenious apparatus, along with sound, practical and economical processes.

XUM

THE NEW ASTRONOMY.

PROOFS OF THE IMPACT THEORY OF COSMIC EVOLUTION

By PROFESSOR A. W. BICKERTON.

I WISH to thank Mr. O'Halloran for his letter on the death of energy in the September issue of "KNOWLEDGE," in which he describes some of the observational and logical evidence tending to prove the theory of the third body. In contrast I may quote the remark made a short time ago by one of our ablest astronomers, who said: "I own your ideas are very suggestive but necessarily incapable of proof." This opinion is shared by other official astronomers. Clearly such an opinion cannot be held by those who have read the mass of evidence published in "KNOWLEDGE" since August, 1911. This alone is quite convincing; yet much of the evidence now available has not yet appeared even in "KNOWLEDGE"; one amongst other reasons being that some of it has been observed or made known subsequently to the publication of those articles and letters. This is especially the case with the wonderful evidence furnished by Nova Geminorum.

There are two fundamental oversights regarding the New Astronomy that seem to be made by almost all astronomers. First, they look upon impact as random and destructive; whereas impact is brought about by many agencies and produces definite results often of amazing complexity. Hence impacts are really a law of Nature, and constructive. Impacts are probably one hundred thousand times as frequent as mere random encounters of stars, situated as our Sun is, would be. The other oversight of many astronomers is the lack of realization on the one hand of the thermodynamic intensity of the phenomena of new stars, and on the other hand of the calorific power of stellar impact. Nova Persei was but a feeble star compared with other historic examples. Yet at its maximum it had ten thousand times the intensity the Sun would have, were both seen by a being situated at the same distance from either star. The Sun at three light years' distance would present the appearance of Nova Persei. Yet the pace of progression of the flash of light that lit up the Perseus nebula shows this nova to be three hundred light years away: that is when placed one hundred times as far away it was as bright as the Sun would be at three light years' distance. 100^2 is 10,000: that is the comparative intensity of Nova Persei in terms of solar units. The Sun, if stoked by fuel, would require six hundred times the known coal-fields of the Earth per minute to keep it going. Hence as a bonfire Nova Persei would require $600 \times 10{,}000$, or six million times the known coal-fields of the Earth to be burnt each minute of maximum to produce such a blaze. Such is the energy of a nova. What is that of grazing suns? Were express trains meeting at three hundred miles a second, which is the speed we may consider that two stars grazing meet at, the collision would have three hundred and twenty-four millions times the energy it would have were the trains meeting at a mile a minute. The thermatol or molecular kinetol, or heat energy of unit mass, would be twenty-seven million degrees. A velocity of three hundred feet a second is approximately the mechanical equivalent of heat; thermatol is proportional to velocity squared, hence three hundred miles a second is clearly five thousand two hundred and eighty squared times as great as the mechanical equivalent: that is, over twenty-seven million degrees thermatol. So a graze of suns exactly corresponds, both in power and equivalent energy, with the observed data of Novae. The observed complex light curve of Nova Persei, which was most completely made, corresponds exactly with that dynamically deduced. The light curve of Nova Geminorum was not able to be so well observed, yet a superposition of the best observed curves shows that the light curves of the two closely resemble one another. Whilst the light curves of Nova Geminorum are not so good as those of Nova Persei, the series of spectrograms obtained are much finer. The Cambridge Spectrograms recently shewn in the Library of the Royal Astronomical Society are minutely perfect and full of detail. Their details are confirmed by each character being shown in many of the series. There is not a physical or chemical fact disclosed by these duplicated details but was deduced and published a long time before the spectrograms were photographed; whereas the perfection of these marvellous spectra supplies physical data that pulverize and blow, to the four winds of the heavens, every fibre of any known theory save that of the third body.

These Novae demonstrate beyond any doubt the fact that they are third stars grazed from colliding suns. Yet Novae so constantly alike are only one of the scores of celestial phenomena, equally striking in the coincidence of deduction and observed fact. Mr. S. N. E. O'Halloran's letter is chiefly devoted to Steinmetz' article showing Kelvin's oversights in coming to his idea of the death of energy. In "KNOWLEDGE" (December, 1911) I show some of the agencies that deductions prove must act together to produce an aggregation of primordial matter, forming cosmic systems of the first order. In *The Phil. Mag.* for August, 1900, I showed that the configuration of our Galaxy suggests it to be made up of a primordial and an old cosmic system interpenetrating. Kapteyn's statements show that observation confirms this deduction.

In "KNOWLEDGE" for December, 1911, the

whole evolution of the Galaxy is deductively shown. Let us see how far facts confirmed the deductions. We assume that the two Nubeculae and the Nebula of Andromeda may be independent sidereal systems. The other white nebulae we deduced should avoid the Milky Way; which a summing up of the latest observations shows they do. On the other hand, as deduced, gaseous nebulae of all kinds are found in the Milky Way; as are nearly all the objects deduced as being produced by the impact of suns. These are temporary, variable, double and Wolf-Rayet stars; spectroscopic binaries, star clusters and planetary nebulae; almost all of which are in the Galactic Zone or the Nubeculae.

The investigations of Victor Anestin and the Rev. T. E. Espin show conclusively the coincidence in position of many of these celestial objects and those parts of the Galaxy where stars tend to crowd.

There is a vast mass of other deduced coincidence that it would be most valuable work to confirm; work of such a nature that the equipments of great observatories would be required; yet amateurs could do much valuable work. There is not a single character of all the complex types of any one of the variable stars known but can be deduced as the product of impact of some kind or other.

The pairing of variable stars was deduced and afterwards confirmed; the double variability of double stars was anticipated in the same way, so was the association of double stars with nebulae. Not merely were the constancy of some and the irregularity of others, and the many variations of the light curves of stars deduced, but the cause of their frequent nebulosity at minimum has been most clearly shown.

So recondite were many of the deductions made and published a third of a century ago, that I thought it impossible that much of the work would be confirmed in my lifetime. I had no conception even that in the Earth's whole history many of the deductions of the researches now proven to be true by observation would ever be so. I thought that, in time, the kinetics and kinematics would be seen to be so sound that they would serve as working hypotheses. Of course, it is the arming of the telescope with the prism and photographic film that has placed such unexpected power in the hands of observers. The above is a broad outline of the generic coincidence between observation and fact. I have not attempted in any of these classes to give the details. I would, however, ask any astronomer who is not prepared to accept the Impact Theory of Cosmic Evolution to answer the one question: How does he account for the pairing of many variables, and the variability and double variability of many binaries? There must be some law at work; for in each case the statistical probabilities are many millions to one against such an occurrence being chance.

So far as I know there never has been a single argument against this generalization. Every deduction has been examined over and over again by experts and found to be soundly based on natural law. Its vast scope is the only thing that made it suspect in New Zealand, and no celebrated English astronomer, except Father Sidgreaves, has ever seriously studied it, and he has approved it in unmistakable terms. Two New Zealand astronomical mathematicians, C. E. Adams, Government Astronomer, and E. C. Gifford, Herschel Scholar of Cambridge, have devoted themselves to a most detailed examination of every branch of the correllation, extending over a score of years, and these able astronomers declare that observational astronomy would a decade ago have been where it is now had this generalization been used from its publication as a working hypothesis to guide research. Professor Rutherford, F.R.S., who investigated it in great detail when studying in my laboratory in New Zealand, has repeatedly spoken of his high opinion of the theory as a working hypothesis.

One thing is clear: that in the study of celestial collisions and interpenetrations the problems must be taken in two parts: the actually meeting parts that coalesce and form a third body, and the parts that escape collision, but are profoundly modified by the event. The physics of the two are so dissimilar that they must receive separate investigation, whether we are studying the collisions of suns, nebulae, meteoric swarms, or sidereal systems; whether the impact be a mere graze or a deep case of whirling coalescence. Always the chemical and thermodynamic problems are quite unlike.

It is the opinion of those who have known the whole generalization that it introduces many scores of principles not yet recognised by science. This is apart from its astronomic value. Yet, in this respect it is now quite proven. Years ago Gifford said of it: "In 1878 the facts on which the impact theory relied were few, though sufficiently striking. Now they are innumerable."

Many favourable criticisms from many well-known scientific men have appeared respecting the long illustrated articles published in "KNOWLEDGE" (September, 1911, *et seq.*); and although many journals have printed long appreciations of these articles—several appreciations running into many thousands of words—*The Scientific American* occupying two pages, newspaper size; on the other hand, no words of adverse criticism have ever appeared, nor has there been any adverse comment on the widely-reported Royal Institution lectures. With all this publicity no learned society and no university has ever debated the generalization, and this in the face of the fact that recent observed discoveries have disproved all the old theories of astronomical origin. Yet these same observations have demonstrated the accuracy of this theory of cosmology down to the minutest detail.

What is the scope of this generalization? It shows the genesis of every body and system in the universe and of the very sidereal system itself. It interprets the details of every light curve and every complex spectrogram. It shows there is another

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aggregating power in Nature besides gravitation, consisting of a series of agencies acting chiefly on elements of low atomic weight, and hence appropriately called Levitation. Every step of this reasoning has been examined by able mathematical physicists, and stated to be mathematical "*verae causae*." This new discovery alone is of such scientific importance as to absolutely remove the cosmic application of the theory of dissipation of energy, with its dismal doctrine of eternal death. It shows the scheme of creation to be infinite and immortal. It shows that gravitation and levitation mutually correllate each other and are complementary agents in an eternal rhythm. Gravitation tends to collect and concentrate the heavy elements into dark stars, and may be looked upon as the chief factor of death; whilst levitation collects the light elements and gives birth to primordial systems—cosmic systems of the first order. Then, by the interpenetration and interfusion of the two, we get virile sidereal systems; of which our galaxy is a type. Eminent astronomers tell us in unmistakable language that within this vast sidereal system of which the solar system is a part, they can observationally trace every characteristic that deduction says such a mode of origin should present. The onrush of the primordial and effete systems can still be traced. The rejuvenating mechanism of eternal physical life is thus actually seen in process within the galaxy itself. The whole mechanism of cosmic re-birth being thus not merely shown to be true by irrefutable dynamical deduction, but also confirmed, decades afterwards, by the latest observations of the most refined of astronomical methods.

CORRESPONDENCE.

FERTILISATION OF THE FIG.

To the Editors of "KNOWLEDGE."

SIRS,—The interesting questions raised by your correspondent "I.L.J.", and some similar inquiries addressed to me by other readers of "KNOWLEDGE" with reference to my article on the above subject in the August issue of this journal, call for some further explanations, for which I trust you will be kind enough to afford space in these columns, and which I ought perhaps to have incorporated in that article.

The article in question was based, as stated, upon the recent interesting investigations made by Ravasini and communicated by Tschirch on the wild and cultivated figs of Italy (Ravasini has himself just published his results in a German memoir), but I might have pointed out more explicitly than I did that, as suggested by "I.L.J.", the complete life cycle of the Fig, as worked out by Ravasini in Italy, is by no means realised in more northerly countries. As cultivated in Britain, the fig tree produces only two generations of inflorescences each year, and of these only one, as a rule, ripens outside. The first generation or crop is produced in early summer from buds of the former year, the second in autumn from those on the spring shoots; these apparently correspond respectively to the "pedagnuoli" and the "cimaruoli" of Italy and the Mediterranean countries generally, the "fiori di fico" being absent from the northern countries, though by growing selected varieties in a hothouse all three crops may be obtained. In outdoor plants in this country, the first shoots usually appear in May and bear young figs in July or August; but these rarely ripen properly owing to the shortness of our summer. The later midsummer shoots produce young inflorescences, and these do not develop until the following spring—it is upon these alone that the British grower can depend, as a rule, for a crop of ripe figs.

I have not yet been able to ascertain whether or not experiments have been made in this country concerning the production of fertile seed by figs grown here, though I have examined microscopically large numbers of "ripe" figs grown in various parts of Southern England and the Channel Islands, and have never found either wasps, male flowers, nor embryo-containing seeds. It should, of course, be noted that the inflorescences become enlarged and succulent quite apart from fertilisation, though they are not mature in the sense of containing fertile seeds as do those imported in the dried condition from Asia Minor. Until recently, it was thought that the production of mature seed-bearing figs was absolutely dependent upon having in the vicinity of the ordinary female tree one or more of the male trees (the "Caprificus"), and excellent results in the form of improved fruits have been obtained by introducing the "Caprificus," or the Wild Fig, into countries where only the female fig tree had been previously cultivated—the pollinating wasps being, of course, introduced simultaneously with these plants which they infest. This course was adopted, for instance, in California a few years ago, and had already been resorted to in various European countries. The wasps are extremely small, only about a millimetre across, and can, therefore, easily enter the narrow orifice of the inflorescences. However, until the question of the fertilisation of the fig has been thoroughly investigated in Britain, it is difficult to say in how far Ravasini's observations apply to figs grown outside of Italy and the other Mediterranean countries. It has been suggested that the better maturation of the fruit resulting from the intervention of the wasps or from "caprification" is attributable to the stimulus induced by the insect's ovipositor, and not to the pollination of the female flowers, and that the mere thrusting of a straw into the inflorescence may have the same effect. Moreover, some recent writers have described the production of fertile seeds, capable of germinating and giving rise to new fig plants, in the complete absence of the male flowers and the wasps—that is to say, should these observations be confirmed, the fig will have to be added to the small but growing list of plants in which parthenogenesis is known to occur either occasionally or regularly, the egg-cell in the ovule developing into an embryo without the entrance of a male germ-cell.

I must, however, apologise for the length of this communication, and for the lack of definite information which I have so far been able to obtain concerning the life cycle of the fig tree as grown in Britain. As a matter of fact, one of the reasons for my having contributed to "KNOWLEDGE" the gist of Ravasini's important work on the fig in Italy was the hope that some of your readers might feel inclined to take up an interesting branch of study and help in clearing up some of the difficulties of the "fig problem." It would be interesting to have the results of observations in different parts of this country, which might contribute to our knowledge by answering the following and other questions. — Does the ordinary fig tree produce any male flowers in its inflorescences? Does it produce fertile seeds containing an embryo and capable of germination? Does the production of such fertile seeds depend upon the presence of the male tree or Caprifig? Do the fig wasps ever occur in the inflorescences of the ordinary Fig in this country? Does the Fig produce fertile seeds by parthenogenesis?

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EDIBLE AND POISONOUS TOADSTOOLS.

By SOMERVILLE HASTINGS, M.S., F.R.C.S.

Is it edible? Is it poisonous? These are usually the first questions that come to the mind of anyone who is shown a toadstool of any kind, quite irrespective of whether the person concerned is accustomed to regard the articles of his diet with peculiar interest or not. It is perhaps a very primitive instinct that prompts us to enquire as to the food value of anything we notice for the first time.

In this short article it is proposed to say something about the edible and poisonous qualities of mushrooms and toadstools and then to consider of what use these properties are likely to be to the fungus plant.

An exceptionally large number of cases of poisoning by toadstools occurred during the present autumn (1912), particularly in the rural districts of France. On September 11th last, no fewer than twenty cases, six of them fatal, were reported in the *Figaro*, of Paris. Of our English species one hundred and ninety-four are mentioned by Dr. Cooke as having been described as edible by different authorities, and of these Dr. Cooke has himself sampled sixty-nine in sufficient quantity to be sure that they are harmless. About thirty or forty species are described as poisonous: many of them, it would appear, upon rather slender evidence; for when one begins to enquire why they are considered poisonous, one is met by considerable difficulty, for not infrequently one finds that a species described by one writer as poisonous is recommended by another as edible, especially when the writers are referring to different countries. No doubt many of these discrepancies are the result of mistakes in the identity of species; but the character of the soil, the amount of moisture which it contains and the temperature at which the toadstool develops would appear to be factors of considerable importance also. Thus the Scarlet Fly Cap (*Amanita muscaria*) (see Figure 493), a particularly definite and easily recognised species, of the poisonous qualities of which in this country there is ample evidence, is stated by more than one author to be regularly eaten as an article of diet in parts of France and Russia. Even in the same locality the chemical composition of fungi seems to vary considerably, and cases of poisoning, some of which resulted in death, have even been recorded in connection with the Common Morel (*Morchella esculenta*). (See Figure 496.) The proportions of poisonous substances in individuals of the same species have also been shown to vary considerably. Some exist only for a short time in the life of the toadstool, and others develop only with commencing decomposition. Helvellic acid, a very poisonous substance, is present in mature and old specimens of *Helvella esculenta*, but is entirely absent in young and fresh.

FIGURE 491.
The Death-cup (*Amanita phalloides*).

Choline, a comparatively harmless alkaloid which has been isolated from several species of toadstool, changes on decay to the deadly neurine, which resembles in its action muscarine, the poisonous principle of the Scarlet Fly Cap.

Some of the toxic substances are volatile, others are destroyed by heat and most are soluble in water, especially if acidulated or containing salt. Frédéric Géraud gives a recipe for preparing every kind of toadstool, even the most poisonous, for the table. He has himself repeatedly tried it and proved it to be effective. The toadstools are cut up into small pieces and steeped in water to which vinegar or salt has been added, for at least two hours. They are then washed thoroughly and boiled for half an hour, washed again, and may then be prepared as desired. It is wonderful what extraordinary things some people will try to eat.

The amount of a poisonous toadstool that is required to give rise to symptoms of poisoning of course varies with the species taken; for some are much more poisonous than others. But there are also marked differences in susceptibility in different individuals. Where several people have partaken of the deadly dish, and are consequently affected, the severity of the symptoms in no way corresponds with the amount of the toadstool eaten.

It may be useful here to enumerate the species of whose poisonous properties there is definite evidence.

The Death-cup toadstool (*Amanita phalloides*. Figure 491) is a harmless-looking fungus with an earthy, and not unpleasant, smell. Its cap is usually pale olive green in colour, rather slimy,

FIGURE 492.
The Liberty Cap (*Psilocybe semilanceata*).

and has one or two largish white scales sticking to it. These are parts of the volva which enclosed the toadstool when immature. Other remains of the same are seen in the cup at the base of the stem. The toadstool has white gills and a white ring near the top of the stem. It grows in woods. Though so innocent-looking, it is responsible for more than half of the cases of toadstool poisoning and for ninety per cent. of the deaths. Victor Gilet found one hundred and fourteen cases recorded in the literature, and seventy-three of these were fatal. It is probable that this death-rate of sixty-four per cent. is rather too high, because fatal cases are much more likely to be recorded than those less severe. The poisonous properties of the Death-cup appear to be mainly due to an albuminous substance, phallin, which is obtained from an aqueous extract of the fungus; it is not unpleasant to the taste, but is very fatal when administered to cats and dogs. It dissolves the blood corpuscles and coagulates the blood, and on this action its poisonous properties mainly depend. The symptoms produced by phallin are not, however, exactly like those which develop when the Death-cup toadstool is eaten, and it is very likely that other toxic substances exist as well. Three other poisonous substances have been described by different observers. One of them, amanitine, is purely narcotic in its action; the others, bulbosine and phalloidine are alkaloids. Not till eight to twelve or even twenty-four hours after the toadstool is eaten do symptoms usually develop. The patient then begins to suffer from what might easily be mistaken for severe cholera with nausea and watery diarrhoea, cramps, convulsions and collapse. Death may take place about the second or third day, or the condition may improve. Often, however, this improvement is only temporary, for within two or three days the symptoms return, and a condition resembling severe jaundice, with stupor, develops, and death occurs about the fifth or seventh day.

Amanita verna is said to give rise to similar symptoms.

The Scarlet Fly Cap (*Amanita muscaria*. Figure 493) is probably the best known of our toadstools. It has a scarlet (at times orange) cap, dotted all over with white warts. These warts are the remains of the volva which covered the toadstool when young. There is no definite cup, but the base of the stem is swollen. The gills are white, and there is a well-marked ring. The fungus is found most abundantly in the neighbourhood of birch trees. In Kamschatka and North-Eastern Asia this fungus is stated on good authority to be regularly used to produce intoxication. The toadstools are collected in the hottest months and hung up to dry. When required for use, they are rolled up and swallowed whole. One large or two small will, in a couple of hours, produce an intoxication that lasts for twelve to twenty-four hours. A feeling of giddiness with exaltation and delirium is produced. The face becomes flushed and the muscular power is increased. In cases of poisoning, the early symptoms, which usually commence within one or two hours of the toadstool being eaten, closely resemble the above; the patient may become actually maniacal. Sickness and diarrhoea are sometimes present. Convulsions and stupor usually follow, and within a few hours the patient becomes drowsy and goes to sleep, and may awake but little the worse for the accident.

FIGURE 493.
The Scarlet Fly Cap (*Amanita muscaria*).

A few fatal cases have been recorded, however. In these the stage of stupor is followed by one of collapse, with embarrassed breathing, blueness of the skin, lowered temperature, and death from heart failure within twelve or thirteen hours of the onset of symptoms.

The poisonous principle of the Scarlet Fly Cap is easily dissolved

FIGURE 494.
The Slayer (*Lactarius rufus*).

out in water. The fungus used to be bruised and steeped in milk, and the milk used for killing flies. Chemists have isolated an alkaloid, muscarine, from it as a clear, syrupy liquid. This substance is very poisonous to animals. It slows the heart and increases secretions, acting in most respects in exactly the opposite way to atropine, the poisonous principle of the Deadly Nightshade (*Atropa belladonna*), and when the heart of an animal has almost ceased to beat through muscarine it may be stimulated to strong action by the use of atropine. But muscarine is not the only poison in the Scarlet Fly Cap, for specimens from which the muscarine has been extracted still give rise to symptoms of poisoning analagous to those which arise in an animal poisoned by the Scarlet Fly Cap and treated by atropine. There is also present in the fungus a second alkaloid, called by Kobert pilz-atropine, which neutralises to a greater or less extent the effects of muscarine. It is very likely that in those parts of France and Russia where *Amanita muscaria* is used for food, the amount of pilz-atropine present in the fungus is relatively large.

The Panther Cap (*Amanita pantherina*) and the Sorceress (*Amanita mappa*) are both poisonous, and give rise to similar symptoms to the Scarlet Fly Cap (*Amanita muscaria*).

Entoloma sinuatum and *E. fertilis*, toadstools with pink spores, nearly poisoned Mr. Worthington Smith, the botanist.

Liberty Cap (*Psilocybe semilanceata*) a small toadstool with a conical yellow cap, dark gills, and a long stalk, commonly found on dung (see Figure 492), appears to have poisoned children on two separate occasions.

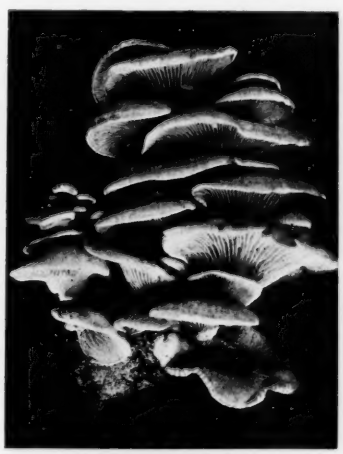

FIGURE 495.
The Pill Sprout (*Panus stypticus*).

The Skull Cap (*Stropharia semiglobata*) a somewhat similar form, also growing on dung, but with a rather larger and more rounded cap and more or less of a ring round the stem, is stated by Sowerby to have proved fatal.

Probably most of the *Russulae* and those species of *Lactarius* with white milk (the edible *Lactarius deliciosus* has red milk) are dangerous. The Emetic Russule (*Russula emetica*) with its bright red cap, the Burning Lactar (*Lactarius pyrogalus*), the Slayer (*Lactarius rufus*. Figure 494), the Fringed Lactar (*Lactarius torminosus*) should especially be avoided. While a good many cases of poisoning from species of *Russula* and *Lactarius* have occurred, none seem to have proved fatal. Within half an hour to an hour vomiting and diarrhoea, thirst and abdominal pains supervene, and are generally followed by giddiness, convulsions and a semi-conscious drunken condition.

FIGURE 496.
The Common Morel (*Morchella esculenta*).

FIGURE 497.
Helvella crispa.

The Pill Sprout (*Panus stypticus*), a small dark brown form with the stem to one side, common on rotting wood (see Figure 495), is said to act as a violent purgative.

The Satanic Boletus (*Boletus satanus*), a large toadstool with a buff cap and bright red pores below it, has proved fatal. It acts as a violent irritant poison when eaten raw or cooked, and causes sickness with bloodstained vomit and diarrhoea with the passage of blood; convulsions and collapse are also present in severe cases. *Boletus luridus* is described as poisonous by some writers and as harmless by others.

The Common Morel (*Morchella esculenta*. Figure 496), has at times given rise to symptoms of poisoning and even proved fatal. Vomiting, depression, cramps, delirium, jaundice and collapse were the chief symptoms.

Helvellas (see Figure 497) are much eaten in France, Germany and Russia; but sometimes cause fatal poisoning. The poison, Helvellic acid, is only present in mature specimens and is easily dissolved out in water. If Helvellas are boiled, squeezed, and dried they are harmless, but the water they were boiled in, though pleasant to the taste, is very poisonous. Dogs drink it readily but are poisoned by it. The principal symptoms produced are sick-

ness and diarrhoea, jaundice, irregular breathing, delirium and convulsions.

The recognition of cases of toadstool poisoning is generally easy; but it is much more difficult, as a rule, to say which toadstool has been taken. A rapid onset of symptoms with drunkenness and delirium strongly suggest the Scarlet Fly Cap (*Amanita muscaria*). An examination of the remains of the meal or of the vomit is of great assistance. The flesh of the Death-cup (*Amanita phalloides*) is seen microscopically to contain large sausage-shaped cells among the smaller threads of the mycelium, and this structure can still be made out even after the toadstool is cooked. The appearance of the spores of several species, notably *Amanita muscaria* and *A. phalloides* and *Russula emetica*, under the microscope, is very characteristic, and, as these structures resist digestion, a diagnosis may sometimes be made by this means.

FIGURE 498.
Shaggy Caps (*Coprinus comatus*).

A word or two on the treatment of toadstool poisoning may not be entirely out of place. The first thing to do is, of course, to endeavour to clear the digestive tract of the poison. Vomiting should be encouraged or artificially produced by mustard and water or other emetics and the stomach may be washed out if this is practicable. Unless there is severe diarrhoea, purgatives should be given. A tea-spoonful of castor oil with one or two drops of croton oil in it has proved most effective. Powdered charcoal (animal or vegetable) should also be administered. Where the toadstool contains Muscarine (*Amanita muscaria*, *A. pantherina* or *A. mappa*) one-hundredth to one-fiftieth of a grain of atropine should be injected hypodermically. In other cases opium or morphia will be useful, both for the intestinal irritation and for the nervous symptoms. Where severe diarrhoea has caused depletion of the tissues of their fluid contents, transfusion with salt solution may be desirable.

Turning now to the general composition of fungi, we find that seventy to ninety-two per cent. is water. Of the dry solids two to five per cent. consist of nitrogen. This is a high percentage, but only one to 3·5 per cent. is combined as proteid. The percentage of mineral salts is high, six to twelve per cent., and these are mainly of potassium with some iron and manganese. There is also in the dried toadstool 1·5 to six per cent. of fats, fatty acids and other substances soluble in ether, the food value of which is doubtful. The remainder is largely carbohydrates, such as cellulose, fungus cellulose, glycogen and mannite. Fungi contain no starch.

The relatively-high percentage of nitrogen would suggest that fungi should have a high nutritive value,

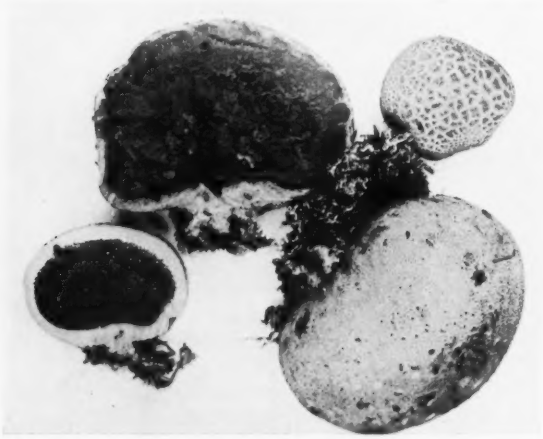

FIGURE 499.
The Common Earth-ball (*Scleroderma vulgare*).

FIGURE 500. *Boletus chrysenteron.*
Showing tooth marks of squirrel which had nibbled the toadstool.

but only part of this is combined as proteid and a much smaller part as digestible proteid. Only one-seventh part of the nitrogen contained in Shaggy Caps (*Coprinus comatus*. Figure 498) can be digested and made use of by the human body. Of all the toadstools, the common mushroom (*Psalliota campestris*) is believed to contain the highest percentage of digestible proteid; yet this is really so small that it is only one forty-seventh of that in beef and one fifty-sixth of that in beans, while it is just about equalled by the proteid contents of cabbage and potatoes. Continuing our comparison with these two vegetables we find that the percentage of fat in mushrooms is about the same as in cabbage, but a little more than in potato, while the carbohydrates, though approximately the same in amount as in cabbage, are only a quarter as abundant as in potato. Clearly, then, from the point of view of actual nourishment, we do just as well on cabbage as on any toadstool, and run much less risk.

But the value of any food is not to be measured entirely by the percentage of digestible proteids, carbohydrates and fats that it contains. Many substances having no food value are of use as stimulants to digestion and aids to assimilation. Their action is in part psychological; for there is no doubt that pleasant flavours and aromas stimulate the movements of the stomach and the secretion of the digestive juices.

The conclusion we must come to is, therefore, that certain varieties of toadstool properly cooked are not undesirable constituents of a meal, but that except in the case of a few kinds, like the common mushroom, they are by no means free from risk. There is no rule to distinguish an edible from a poisonous variety. Dependence on some supposed rule has been responsible for a large proportion of the cases of poisoning. The only way is to get to know each edible species, with all its distinguishing characteristics, and to eat no toadstool that does not conform with these in every particular.

Lastly, of what value are the edible and poisonous properties of toadstools to the toadstool plant; There can be no doubt but that the truffles which are found beneath the soil, and are sought for and rooted up and eagerly devoured by pigs, really like to be thus treated; for by this means the spores are distributed in a manner most suitable for their germination. The truffles, with their myriads of contained spores, are the fruits of the truffle plant, and their strong scent is as surely designed to make their presence evident to pigs as are the bright colours of many fruits to make them noticeable to birds. The Common Earth Ball (*Scleroderma vulgare*. Figure 499), a variety of puff ball that has a very thick covering which never spontaneously ruptures, is commonly found perforated in various directions by beetles. No doubt these creatures nibble through the outer covering for what they can get inside, but by so doing they clearly assist in the distribution of the spores.

Many species of toadstool, including the deadly Death-cup, are found eaten by slugs, and a friend once told me that she had watched a squirrel for several minutes nibbling a species of *Russula* with evident relish. Slugs are, however, rather careful of the variety of fungus that they care to tackle. Experiments with slugs kept without food for a couple of days showed that while the Stump Tuft (*Armillarea mellea*), the Emetic Russule (*Russula emetica*), and the Scarlet Fly Cap (*Amanita muscaria*) were readily eaten, the Sulphur Tuft (*Hypholoma fasciculare*) and the Melon Hygrophorus (*Hygrophorus pratensis*) remained practically untouched. The internal economy of the slug must be very different from our own, for some of those species preferred by the slug are to us deadly poisonous. It will be seen from the above that several of the bright-coloured species are eaten in nature and one is inclined to wonder whether the bright colours have any value for attractive purposes. That the brilliant tints of so many fungi are due to no mere accident, and are something more than a method for the disposal of material of no further value to the plant, is indicated by their constant presence in certain species, and by their limitation in nearly every case to that part of the toadstool visible from above, and perhaps most of all by the coloured substance in most cases being found only in a very thin layer of tissue on the upper surface of the cap.

Nevertheless, as will be seen above, a good many species, and among them some of the bright coloured, are rarely, if ever, eaten in nature, and moreover, the umbrella-like form which has proved so successful in the struggle for existence that it is found in many thousands of different species of toadstool, is so excellently adapted for the distribution of the light spores by the wind that it is difficult to imagine that it has been evolved for any other purpose. I would suggest, therefore, that the bright colours of toadstools are for the purpose of making them conspicuous so that they may be avoided and neither trodden on nor eaten by mistake by grazing animals. The fact that many species of black spored toadstools, *Coprinus*, *Paneolus*, *Stropharia* and *Galera* are found almost exclusively on the dung of various herbivora, and that the spores of other fungi have been shown to have been present in the alimentary canal of rabbits, must be only taken to indicate that the spores are able to traverse the digestive tract unharmed, and does not show that fungi are ever eaten by these animals. It is much more likely that the numerous and minute spores have settled on some of the regular food of the animal, and have then been swallowed by accident with it.

But toadstools, especially the gills of those kinds that possess them, are very frequently eaten by slugs, and the observations of Voglino tend to show that this is not altogether disadvantageous to the fungus plant; for the germinating spores of species of *Russula* and *Lactarius* were found in the digestive tracts of slugs fed on these toadstools. Further,

XUM

the spores of other species that would not germinate on ordinary culture media were found to do so readily in the fluid from the digestive tract of the slug. Slugs are eaten by many birds who often fly long distances, and it is possible that in this way the wide distribution of some species of fungus is to be explained. The germinating spores of species of *Lactarius* and *Russula* have been actually found *in* the digestive tracts of toads caught in pine woods, and were probably derived from the slugs that they had eaten.

Perhaps the most striking of Voglino's observations was the following. Ten specimens of a toadstool (*Hebeloma fastibile*) were enclosed as they grew and four starved slugs introduced. The toadstools were eaten, especially their gills. One of the slugs was killed and germinating spores of *Hebeloma fastibile* found in its digestive tract. The other three were left in the enclosure, which was watered with sterilised water, and kept enclosed for nearly a year. Specimens of *Hebeloma* were then found to be more numerous within it than elsewhere in the neighbourhood.

It is probable, therefore, that several species of *Lactarius* and *Russula* are greatly assisted by slugs in their spore dispersal.

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SOLAR DISTURBANCES DURING OCTOBER, 1912.

By FRANK C. DENNETT.

ALTHOUGH the sun was observed every day during October, with the exception of the 26th, only two days (15th and 25th) were marked as being without visible disturbance. Spots were observed on nine days, and faculae on the remaining nineteen. The longitude of the central meridian, at noon on October 1st, was 138°57′.

No. 20.—First seen as a group on the morning of October 5th, but an area near by had shown signs of activity since the 1st, developing minute pores on the 3rd. Upon the 5th the preceding and following spotlets were largest, the former increasing considerably by the 6th. On the 7th when one of the smaller spots had a decidedly vortical appearance, the leader had become 11,000 miles in diameter, and the trailer 13,000 miles. The group was decidedly of an elliptical form. Rapid changes were frequently taking place. On and after the 6th the leader had its penumbra brightening inwards, and the hindermost spot also on the 9th. On the 10th the components had much decreased in size, and next day only one spot, the leader, was visible amid the faculae closing up to the western limb. The outbreak occurred directly south of the place of No. 18.

No. 21.—On the 18th a faculic knot was noted within the eastern limb. Next day closely north-west of this was a penumbraless pore, also surrounded by a facula. The latter was visible on the 20th, but the pore was gone

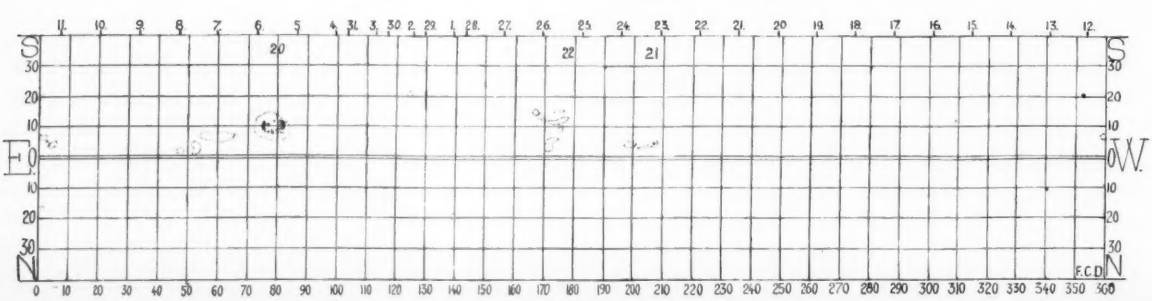
No. 22.—Amid the faculic remains of No. 19, a pore, only lasting one day, was visible on the 29th.

In other ways the photosphere has shown traces of activity, small dusky pores showing, yet not sufficiently well marked for measurement. Particularly was this the case on the 25th, when long serpentine chains of these dusky dots were visible. Also on the 28th in low southern latitude, some three days within the east limb, there was a close group of dull spots, easily seen with the spectroscope, but not so with the telescope.

The faculic disturbances set down on the chart were observed as follows:—That around Longitude 2°, S. Latitude 5°, from October 6th to 8th and on the 16th and 17th; the knot at 1°, 17° N.. on the 17th; that on either side of 50°, 2° S., on the 3rd and 4th; that crossing 60°, at 7° S., on the 10th until the 13th and on the 29th; the knot at 125°, 21° S. on the 24th; that at 140°, 20° N. on the 23rd and 24th; the considerable group about 172°, 12° S. from the 3rd to the 5th, and also on the 30th and 31st; that in the same longitude, but in 5° S. Latitude, from the 20th till the 23rd; and that at 200°, 4° S. from the 18th until the 20th.

Our chart is constructed from the combined observations of Messrs. John McHarg, A. A. Buss, E. E. Peacock, C. P. Frooms, D. Booth, and the writer.

DAY OF OCTOBER, 1912.



THE FACE OF THE SKY FOR JANUARY.

By A. C. D. CROMMELIN, B.A., D.Sc., F.R.A.S.

Date.	Sun. R.A.	Sun. Dec.	Moon. R.A.	Moon. Dec.	Mercury. R.A.	Mercury. Dec.	Venus. R.A.	Venus. Dec.	Saturn. R.A.	Saturn. Dec.	Neptune. R.A.	Neptune. Dec.
Greenwich Noon.	h. m.	°	h. m.	°	h. m.	°	h. m.	°	h. m.	°	h. m.	°
Jan. 1	18 45·7	S.23·0	13 53·4	S. 13·8	17 10·8	S. 21·6	21 44·9	S. 15·4	3 44·3	N.17·6	7 47·4	N.20·6
,, 6	19 7·7	22·5	18 22·9	S. 28·3	17 38·0	22·7	22 7·3	13·2	3 43·4	17·6	7 46·8	20·7
,, 11	19 29·5	21·9	22 31·6	S. 12·1	18 7·8	23·4	22 29·1	10·9	3 42·6	17·5	7 46·3	20·7
,, 16	19 51·1	21·0	2 8·8	N.15·7	18 39·5	23·7	22 50·2	8·5	3 42·0	17·6	7 45·7	20·7
,, 21	20 12·4	20·0	7 6·0	N.27·6	19 12·3	23·5	23 10·7	6·0	3 41·6	17·6	7 45·1	20·7
,, 26	20 33·3	18·8	11 59·8	N. 0·5	19 46·0	22·8	23 30·6	3·5	3 41·4	17·6	7 44·5	20·8
,, 31	20 54·0	S 17·5	16 18·0	S. 26·0	20 20·2	S. 21·5	23 50·0	S. 0·9	3 41·4	N.17·6	7 43·9	N.20·8

TABLE 51.

Date.	Sun. P	Sun. B	Sun. L	Moon. P	Saturn. P	Saturn. B
Greenwich Noon.	°	°	°	°	°	°
Jan. 1	+ 2·0	−3·2	6·2	+19·0	−2·4	−24·2
,, 6	− 0·4	3·7	300·4	+ 2·3		
,, 11	2·8	4·3	234·5	−20·4	2·3	24·1
,, 16	5·2	4·8	168·8	−18·4		
,, 21	7·5	5·2	102·8	− 6·3	2·3	24·1
,, 26	9·8	5·7	37·0	+21·9		
,, 31	−11·9	−6·0	331·2	+ 9·1	−2·3	−24·2

TABLE 52.

P is the position angle of the North end of the body's axis measured eastward from the North Point of the disc. B, L are the helio-(planeto-)graphical latitude and longitude of the centre of the disc.

The letters *m*, *e* stand for morning, evening. The day is taken as beginning at midnight.

THE SUN has commenced his Northward march. Sunrise during January changes from 8–8 to 7–44; sunset from 3–58 to 4–43. Its semi-diameter diminishes from 16′ 18″ to 16′ 15″. Nearest Earth, January 1st, distance 91¼ million miles.

MERCURY is a morning star. It passed greatest elongation 22°·4 W. December 28th. Illumination, January 1st seven-tenths, January 31st twenty-nine thirtieths.

VENUS is an evening Star, approaching its greatest elongation, which it reaches on February 12th. Illumination two-thirds, semi-diameter 10″.

THE MOON.—New $7^d\ 10^h\ 28^m m$; First Quarter $15^d\ 4^h\ 2^m e$; Full $22^d\ 3^h\ 40^m e$; Last Quarter $29^d\ 7^h\ 34^m m$. Apogee $11^d\ 1^h m$, semi-diameter 14′ 44″; Perigee $23^d\ 11^h m$, semi-diameter 16′ 43″. Maximum Librations, 1^d 6° W., 6^d 7° N., 17^d 8° E., 20^d 7° S., 29^d 7° W., February 2nd 7° N. The letters indicate the region of the Moon's limb brought into view by libration. E. W. are with reference to our sky, not as they would appear to an observer on the Moon.

Date.	Star's Name.	Magnitudes.	Disappearance. Mean Time.	Disappearance. Angle from N. to E.	Reappearance. Mean Time.	Reappearance. Angle from N. to E.
1913.			h. m.		h. m.	
Jan. 9	ϕ Capricorni	5·3	5 44 *e*	67°	—	— °
,, 11	70 Aquarii	6·1	7 35 *e*	58	—	—
,, 12	BD − 6°6220	7·0	6 2 *e*	37	—	—
,, 14	BAC 270	6·9	9 19 *e*	25	—	—
,, 16	27 Arietis	6·4	9 13 *e*	356	9 40 *e*	314
,, 17	ζ Arietis	4·8	3 23 *e*	63	4 30 *e*	241
,, 17	BAC 1055	6·9	9 5 *e*	88	—	—
,, 18	χ Tauri	5·3	9 5 *e*	85	10 19 *e*	250
,, 20	BAC 1746	6.5	1 58 *m*	106	2 54 *m*	262
,, 20	49 Aurigae	5·1	10 37 *e*	60	11 35 *e*	313
,, 21	c Geminorum	5·5	11 22 *e*	103	0 32 *m* *	291
,, 24	26 Leonis	7·6	—	—	4 47 *m*	25
,, 26	BD + 3°2539	7·0	—	—	1 49 *m*	300
,, 27	BAC 4220	7·1	—	—	0 2 *m*	300
,, 28	Spica	1·2	1 3 *m*	117	2 8 *m*	314
,, 31	BAC 5347	5·5	4 14 *m*	151	5 11 *m*	256

TABLE 53. Occultations of stars by the Moon visible at Greenwich.

The asterisk indicates the day following that given in the date column.

From New to Full disappearances take place at the Dark Limb, from Full to New reappearances.

Special attention is called to the occultation of the first magnitude star Spica, or Alpha Virginis, on the morning of Jan. 28th. The Moon will be rather low at Disappearance, but the conditions at Reappearance are pretty favourable.

XUM

MARS is a morning Star, but practically invisible.

JUPITER is still practically invisible, having been in conjunction with the Sun on December 18th.

SATURN is an evening Star, 6° South of the Pleiades. Polar semi-diameter 9″. The major axis of the ring is 45½″, the minor axis 18½″. The ring is now approaching its maximum opening and projects beyond the poles of the planet.

East elongations of Tethys (every fourth given). January $3^d\ 1^h{\cdot}5\ m$, $10^d\ 2^h{\cdot}7\ e$, $18^d\ 3^h{\cdot}9\ m$, $25^d\ 5^h{\cdot}2\ e$, February $2^d\ 6^h{\cdot}4\ m$. Dione (every third given). January $3^d\ 11^h{\cdot}6\ m$, $11^d\ 4^h{\cdot}6\ e$, $19^d\ 9^h{\cdot}6\ e$, $28^d\ 2^h{\cdot}7\ m$.

Rhea (every second given). January $5^d\ 0^h{\cdot}4\ e$, $14^d\ 1^h{\cdot}1\ e$, $23^d\ 1^h{\cdot}9\ e$, February $1^d\ 2^h{\cdot}8\ e$.

For Titan and Iapetus, E. W. mean East and West elongations, I. S. Inferior and Superior Conjunction, Inferior being to the North, Superior to the South. Titan, $2^d\ 8^h{\cdot}1\ e$ I., $6^d\ 4^h{\cdot}0\ e$ W., $10^d\ 2^h{\cdot}6\ e$ S., $14^d\ 5^h{\cdot}8\ e$ E., $18^d\ 6^h{\cdot}1\ e$ I., $22^d\ 2^h{\cdot}2\ e$ W., $26^d\ 0^h{\cdot}9\ e$ S., $30^d\ 4^h{\cdot}3\ e$ E. Iapetus $9^d\ 8^h{\cdot}2\ e$ S., $30^d\ 3^h{\cdot}6\ m$ E.

URANUS is invisible, being in conjunction with the Sun on the 24th.

NEPTUNE is in opposition on the 14th. It enters the map of small stars which was given in "KNOWLEDGE" for December, 1911, page 476.

METEOR SHOWERS (from Mr. Denning's List):—

Date.	Radiant. R.A.	Radiant. Dec.	Remarks.
Jan. 2—3 ...	230°	+ 53°	Brilliant shower, swift; long paths.
,, 3 ...	156	+ 41	Swift.
,, 11—25	220	+ 13	Swift, streaks.
,, 17 ...	295	+ 53	Slow, bright.
,, 17—23	159	+ 27	Swift.
,, 25 ..	131	+ 32	Swift.
,, 29 ...	213	+ 52	Very swift.

DOUBLE STARS AND CLUSTERS.—The tables of these given last year are again available, and readers are referred to the corresponding month of last year.

VARIABLE STARS.—Tables of these will be given each month; the range of R.A. will be made four hours, of which two hours will overlap with the following one. Thus the present list includes R.A. 4^h to 8^h, next month 6^h to 10^h, and so on. In the case of Algol variables, the time of one minimum is given where possible, and the period. Algol, owing to its brightness, will be given for wider limits.

Star.	Right Ascension. h. m.	Declination.	Magnitudes.	Period. d. h. m.	Date of Minimum. d. h. m.
Algol	3 2	+40°·6	2·3 to 3·4	2 20 49	Jan. 2 5 28 *m*
RV Persei	4 5	+34 ·0	9·5 to 12	1 23 22	
RW Persei	4 14	+42 ·1	8·5 to 11	13 4 51	
RS Cephei	4 50	+80 ·1	9·5 to 12	12 10 5	
TT Aurigae	5 3	+39 ·5	7·5 to 8·5	0 16 0	Jan. 2 2 6 *m*
RY Aurigae	5 12	+38 ·2	10·5 to 12	2 17 25	
RZ Aurigae	5 44	+31 ·6	9·5 to 12.5	3 0 15	
SV Tauri	5 47	+28 ·1	9·5 to 12	2 4 0	
SV Geminorum	5 55	+24 ·5	9·5 to 11	4 0 10	
RW Geminorum	5 56	+23 ·1	9·5 to 11	2 20 46	
RW Monocerotis	6 30	+ 8 ·9	9 to 10·5	1 21 45	
RX Geminorum	6 44	+33 ·3	8·5 to 9·5	12 5 0	
RU Monocerotis	6 50	− 7 ·5	9·5 to 10·5	0 21 30	
R Canis Maj.	7 15	−16 ·2	6 to 6·5	1 3 16	Jan. 1 0 6 *e*
RV Geminorum	7 22	+15 ·8	8·5 to 10·5	9 7 13	
Y Camelop	7 29	+76 ·3	9·5 to 12	3 7 20	
RR Puppis	7 44	−41 ·2	9·5 to 10·5	6 10 19	
V Puppis	7 56	−49 ·0	4 to 5	1 10 54	Jan 4 0 48 *m*

TABLE 54.

Of long period variables o Ceti (Mira) will reach a maximum at the end of April, when it will be invisible in the sunshine, but it may be seen brightening early in the year.

NOTES.

ASTRONOMY.

By A. C. D. CROMMELIN, B.A., D.Sc., F.R.A.S.

POSSIBLE SCREENING ACTION OF MATTER ON GRAVITATION.—An article by Professor de Sitter in *The Observatory* for November describes some recent researches both by him and Herr Bottlinger, of Munich, as to whether any traces can be detected of diminution of the sun's attraction on the moon during the times when she is immersed in the earth's shadow. They both independently found that some hitherto unexplained oscillations in her motion, which were brought to light by Professor Newcomb's analysis of the observations, could be explained on this hypothesis; and, further, there were some prospects that the large oscillation with a period of some three centuries, which has hitherto baffled all the efforts of lunar theorists to find an explanation, might likewise be due to the same action. This last is still only a conjecture, but the suggestion seems worthy of further research. The suggestion is by no means a new one; it was the basis of Le Sage's explanation of gravity by "Ultramundane corpuscles." These were supposed to be tiny atoms flying through all space with immense speed, and penetrating the interior of all bodies, meeting, however, some obstruction in doing so; thus two neighbouring bodies would screen each other to some extent, and each would have a greater bombardment on the side away from the other, so that there would be a resultant force pushing the bodies together.

If the theory is true, many of the fundamental constants of astronomy will need some modification. For example, the nearer portions of an attracting body like the sun will screen the more distant portions, so that the attraction of the latter will be diminished, and its real mass would be somewhat greater than that assumed; also a sphere would no longer attract as though its mass were concentrated at its centre.

XUM

The effect of this would be more in evidence the nearer the attracted body was to the sun; it seems possible that the anomalous motion of the perihelion of Mercury might thus be explained. It will, of course, be understood that the screening action must be extremely slight, and any effects can only be detected by the greatest care both in calculation and observation.

COMETS.—In addition to Gale's comet, mentioned last month, two others have been discovered. The first, found by M. Schaumasse at Nice, proved to be Tuttle's comet, which had returned two months earlier than was expected. No one had computed the perturbations for this revolution, and M. Fayet has since found that the action of Jupiter in 1901, when there was a pretty near approach of the comet to it, will fully explain the change of period. This has been the shortest revolution of the comet since it was first seen, in 1790, and it is curious that the last revolution of Halley's comet was also a shortest on record. The period of this comet is thirteen and a half years, and six revolutions do not differ much from seven of Jupiter, so that the perturbations repeat themselves, and there is a wave in the periodic times, similar to the one I showed for Encke's comet some time ago.

Years of Perihelion.	Julian Day of Perihelion.	Interval.	Instantaneous Period at Perihelion.
1790.....	2374874·89		
		5027^{d}·38	5060^{d}·37
1803.....	2379902·27*		
		4941 ·51	5017 ·03
1817.....	2384843·78*		
		4949 ·85	4940 ·52
1830.....	2389793·63*		
		4954 ·33	4961 ·51
1844.....	2394747·96*		
		4986 ·58	4977 ·31
1858.....	2399734·54		
		5029 ·26	5020 ·12
1871.....	2404763·80		
		5032 ·35	5047 ·06
1885.....	2409796·15		
		4983 ·37	5023 ·89
1899.....	2414779·52		
		4924 ·89	4991 ·85
1912.....	2419704·41		4912 ·(?)

The following table gives the elements of Tuttle's Comet by MM. Fayet and Schaumasse, and of Borrelly's Comet (c 1912) by Dr. Kobold:—

	Tuttle.	Borrelly.
T	1912, Oct. 28·4106 Paris M.T.	1912, Oct. 21·95 G.M.T.
ω	206° 51′ 29″	101° 31′
Ω	269 33 57	144 53
i	55 0 24	124 9
log q	0·01191	0·0457
e	0·8183†	

Tuttle's Comet will be too far south for European observation in December.

Borrelly's Comet will be in R.A. $19^{h}\ 58^{m}$, N. Dec. 3° 14′ on December 1st; daily motion $+2^{m}\ 24^{s}$, South 45′. It will be of the tenth magnitude.

Gale's Comet may still be seen in the telescope.

Place on December 4th, R.A. $16^{h}\ 34^{m}\ 55^{s}$, N. Dec. 46° 56′.
" " " 8th, R.A. $16^{h}\ 40^{m}\ 25^{s}$, N. Dec. 49° 50′.

BOTANY.

By PROFESSOR F. CAVERS, D.Sc., F.L.S.

BOTANY AT THE BRITISH ASSOCIATION.—The Presidential Address given by Professor Keeble to Section K (Botany) was exactly what might have been expected from one who has shown in his publications how even the most specialised of subjects may be made intelligible and fascinatingly readable to the non-specialist, if presented in that lucid style which is either a happy knack or the outcome of an infinite capacity for taking pains. Professor Keeble's introductory remarks were both witty and wise. He began by comparing himself with Autolycus, as one who had worked on the border-lines of several biological sciences, though readers of his wonderful little book "Plant-animals" would certainly not be inclined to consider the results of its author's brilliant investigations as "unconsidered trifles." After discussing the merits and drawbacks of the general and special methods for a presidential address, the President compared the specialisation of science in our times with the versatility of the great Victorian naturalists, and passed some searching criticisms on our methods of University teaching in science.

ANIMAL PARASITES OF PITCHER-PLANTS.—Jensen (*Ann. jard. bot. Buitenzorg*, Suppl. 3, Part 2) has described an interesting case of symbiosis or parasitism, analogous to the presence of intestinal parasites in animals, in the pitchers of *Nepenthes*. These pitchers are, as is well known, filled with fluid containing ferments in which dead insects are digested, but Jensen has found that several species of fly larvae develop normally in this fluid. So abundant are they that the author found them in every one of the hundreds of pitchers he examined during several successive years in Java. These dipterous larvae were reared, and six of the seven discovered in this curious habitat were found to be new species, belonging to three different families of Diptera. One of the most remarkable characters of these larvae is their power of "anti-fermentation," which appears to retard the action of the ferments in the fluid filling the pitchers. This retarding action was definitely proved by experiments, the larvae being placed in solutions of pepsin and pancreatin. Closely related larvae taken from neighbouring pools were unable to live in the pitchers, hence the anti-ferment is to be regarded as an adaptation to this symbiotic mode of life.

ORCHIDS AND THEIR FUNGUS-GUESTS. — The roots of various orchids contain a helpful fungus which enables them to absorb food from decaying humus. Bernard (*Ann. Sci. Nat., Bot.*, IX., 14) has shown that small portions cut from the bulbous parts of some orchids appear to have a poisonous effect on the root-inhabiting fungus or mycorhiza of the same plants. In cultures the fluid diffusing from the bulb material killed the threads of the fungus. When heated to 55°C. the toxic properties of the bulb are destroyed, and this with other data leads to the conclusion that the substance acting as a fungicide is a ferment (enzyme). It serves to explain the fact that no endophytic fungi are found in the bulbous portions of various orchids which contain fungus in their roots, and also confirms Bernard's view that these orchids tolerate the mycorhiza, though well able to defend themselves against its complete invasion of their tissues.

CHEMISTRY.

By C. AINSWORTH MITCHELL, B.A. (OXON.), F.I.C.

EFFECTS OF STERILISING SOIL. — A series of instructive investigations upon the sterilisation of soil by means of steam has recently been published. The principal chemical changes that take place when the soil is subjected to the action of steam under pressure are described by Messrs. Lathrop and Schreiner, in *The Journal of the American Chemical Society* (1912, XXXIV, 1242). From their experiments it appears that the proportion of substances soluble in water is increased by the process, while the acidity of the soil is also increased, even though ammonia and allied compounds are simultaneously produced. Most of the organic compounds that have been isolated from ordinary soil also show an increase after the steaming, nucleic acid being an exception.

Products of the decomposition of nucleic acid and proteins which are favourable to the growth of plants are formed in the steaming process; but there is also a simultaneous

* At these returns the comet was not seen; the values are calculated by Clausen.

† I have corrected this value to correspond with the actual period of the comet; the authors gave 0·8055.

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production of injurious compounds such as dihydroxystearic acid.

Comparative experiments with steamed and unheated soils showed that poorer growths were obtained with the former, and from this the inference is drawn that the production of injurious substances outweighs that of the beneficial compounds, and that until the former are eliminated it is not possible to ascertain to what extent steaming may be beneficial.

Conclusions of a similar character are drawn by Messrs. Lyon & Bizzell in a paper communicated to the Eighth International Congress of Applied Chemistry (*Original Communications*, 1912, XV, 159), in which the results of re-inoculating steamed soil with fresh and with heated soil are described.

At first the best growth of plants was obtained on soil that had been inoculated with fresh soil, but this did not continue. The luxuriance of growth appeared to depend not so much upon the available nutritive substances present as upon the amount of toxic compounds produced by the steaming, and this factor varied with the nature of the organic substance in the original soil. Aëration of the soil and the growth of plants both reduced the toxic character of the steamed soil, but the speed of oxidation was not always a measure of the rate at which the soil ceased to be toxic.

GEOLOGY.

By G. W. TYRRELL, A.R.C.Sc., F.G.S.

STRATIGRAPHY AT THE BRITISH ASSOCIATION.—As might have been expected, Scottish stratigraphy bulked largely at the Dundee meeting. Two important announcements were made of the discovery of fossils in the hitherto barren Highland Border Series. This is a narrow band of crushed shales, cherts, grits, and calcareous beds, occasionally with igneous rocks, occurring at intervals along the Highland Border fault from Arran on the West to Stonehaven on the East Coast of Scotland. The fossils have been discovered by Dr. T. J. Jehu near Aberfoyle, and by Dr. R. Campbell at Craigeven Bay, near Stonehaven. In the Aberfoyle district, between Loch Lomond and Callander, the Border Series is separated by a line of thrust from the Leny Grits (Dalradian) to the north, and by a reversed fault from the Lower Old Red Sandstone to the south. The fossils have been found in muddy films in grey chert bands, one to three inches thick, and consist, as determined by Dr. B. N. Peach, almost entirely of hingeless brachiopods belonging to the following genera:—*Acrotreta*, sp.; *Lingulella*, sp.; ? *Obolus*, sp.; *Obolella*, sp.; and flattened chaetae of Polychaete worms. This assemblage indicates that the series is probably of Upper Cambrian age.

The Border Series near Stonehaven consists of crushed spilitic lavas with intercalated black shales, jaspers and cherts. In August, 1909, Dr. Campbell, with Drs. Peach and Gordon, succeeded in finding fossils in the black shales. Mr. Tait, of the Geological Survey of Scotland, subsequently made a detailed search in the fossiliferous beds, and the material obtained by him, submitted to Dr. Peach for determination, yielded the following forms: — *Lingulella*, *Obolella*, *Acrotreta*, *Linarssonia*, *Siphniotreta*; a bivalve phyllocarid allied to *Caryocaris* and *Lingulocaris*; and cases of a tubicolar worm. Since graptolites are absent from this assemblage, Dr. Peach believes that it indicates an Upper Cambrian, rather than an Ordovician age. The Border Series is here separated from the Dalradians by a reversed fault, and is overlain unconformably by strata of Downtonian age.

Dr. R. Campbell also described his recent researches in the Downtonian and Old Red Sandstone of Kincardineshire. The rocks now assigned to the Downtonian are a series of vertical or highly-inclined strata, three thousand feet thick, consisting of breccias, mudstones, shales, volcanic conglomerates and tuffs. These strata have yielded *Dictyocaris* in abundance, also *Ceratiocaris*; *Archidesmus*, sp.; a new genus of Myriapod; *Eurypteri ri*, sp., nov.; and plates of a new *Cyathaspis*. The volcanic conglomerates indicate that the volcanic activity destined to play so large a part in the history of the succeeding Old Red Sandstone, had already been initiated in Upper Silurian times.

The highest beds of the Downtonian pass up conformably into the micaceous sandstones and conglomerates of Stonehaven, which are considered as the base of the Lower Old Red Sandstone in this area. The latter consists of a great thickness of coarse conglomerates and sandstones, with lavas and tuffs. The recognition of certain well-marked volcanic zones has been of assistance in working out the stratigraphy. The lavas include dacite, hornblende-biotite-andesite, augite-andesite, hypersthene-andesite, hypersthene-basalt, and olivine-basalt. Minor intrusions occur in the form of dykes and sills of quartz-porphyry, biotite-porphyry, dolerite, and lamprophyre. The coarse conglomerates which form so large a part of the succession may be divided into two groups; those built largely of quartzites and other Highland rocks; and those consisting mainly of volcanic rocks — the volcanic conglomerates.

Further excavations among the Cambrian rocks of Comley, Shropshire, are described by E. S. Cobbold. These have disclosed green sandstones of Lower Cambrian age in Comley brook, in which fossils characteristic of the *Olenellus* limestone of the district have been found. A Middle Cambrian breccia has also been discovered largely composed of débris of the above-mentioned sandstone, but the matrix of the breccia has yielded a *Paradoxides* fauna new to the district.

MICROSCOPY.

By F.R.M.S.

NOTE ON PREPARING FLIES' TONGUES FOR THE MICROSCOPE.—The short-horned Diptera possess a singularly beautiful organ in their tongue or proboscis,—either appellation is justifiable—produced by the fusion of two lateral maxillae. The chitinous cuticle or skin is studded with numerous sclerites or hard pieces, usually of a dark brown colour; and these sclerites occur in several series, some constituting supports for the organ, some the bases of the sucking pad on each side, and some the C-shaped supports for the canals which traverse its under surface. The transition from one of these series to another is not abrupt; the accompanying figures show the passing of the basal sclerites into those of the canals. In a typical fly there are three series of basal sclerites, central, anterior, and posterolateral. The central ones are in many species partly modified into the organs which have been described in the pages of *Science Gossip* as "Flies' Teeth"; these alternate with sclerites supporting the junctions of the canals. The terminal canals frequently give off secondary canals, and therefore are distinguished as anterior and posterolateral. These may be well seen in Mr. Senior's excellent photograph, Figure 270 in our June number. In the picture of *Calliphora vomitoria* (see Figure 501), the four broader black bands at the base represent the "teeth," though their free extremities, shaped like chisels with a triangle taken out of the edge, are not here in focus. In many genera, though not in all, there are several rows of these teeth, placed one behind the other. Internally they have muscles attached to them; and it may be remarked that two kinds of striated muscle are to be found in the proboscis of most flies; the arrangement of the musculature being very complex. Its main attachments are to the posterior transverse median sclerite, its accessory, the posterior lateral, and the inferior basal; these will be noticed as prominent black marks crossing the suctorial surface in Figure 270. It is necessary to give names to these pieces of chitin, as they occur with great regularity in the different groups of flies, sometimes one, and sometimes another, being especially developed or reduced. In *Dolichopus*, for example, the central basal sclerites are fused,

and the anterior and posterolateral ones are missing, so that there are no secondary canals; the posterior lateral sclerite is very large, and there are only six or seven canals, each with a very few supporting sclerites, which have prominent squared ends and very thin curved backs; each of these seems to be in reality compound. So distinct is the type of proboscis that there can be no doubt whether a fly belongs to that group or not; and the same may be said of *Scatophaga*, of the different Syrphids, and probably of any genus of the Brachycera. Dipterists, of course, have other characters to guide them, but these other characters are also concerned with modifications of the chitinous parts, so that the microscope may be of use in supplying additional characters. A good deal may be seen of the working of the proboscis in the living fly; but there are certainly some points in its action not yet clearly made out. The pure microscopist knows the blow-fly's tongue as a test object; but the tongue of the house-fly is really better for this purpose, as the supporting sclerites of the canals are relatively less spirally twisted, and consequently more distinct. Viewed on the open side they look like a row of arrows and croquet mallets placed alternately, side by side; we must imagine the letter C, to which they have been compared above, to have its lower limb split, forming a small V. When one looks over the tongues of a number of different species, a great number of variations on this pattern are found; indeed the canal sclerite of a fly seems to be as characteristic as the spicule of a sponge. We also notice that the type used in the canals of some species is used in the supporting parts of others; and hairs may also be found of such a form and distribution as to suggest that all these objects, even the "teeth," are in reality modified hairs.

It is of some importance to the microscopist to be assured that his test object is of the species named; I have seen the proboscis of *Eristalis* labelled "Tongue of blow-fly"; these Syrphids have the intercostal distances of the canal-supports often less than one micron, so that their resolution forms a test of a different order. In the Cordyluridae the distances are also short, but owing to the flattened form of the sclerites resolution is much easier. The preparation of these organs is not a difficult matter. You may soak the fly's head in caustic potash or other alkali to dissolve the muscles, afterwards washing it and bringing it into acetic acid for the actual dissection. A much easier plan, which I find more satisfactory, is to take a dried specimen, remove the organ with the point of a pin (this may often be done without damaging the remainder of the fly), and put it into a drop of strong acetic acid, which will soften it in a few minutes or hours as the case may be. Next remove as much of the acetic acid as possible by means of blotting paper, and substitute a drop of good creasote. This will clear and dehydrate, and dissection may be performed in this medium very easily. In order to show the suctorial pad I detach it from the rest of the tongue, so that it is freed from the intrinsic muscles and the external surface with its hairs. This little operation can best be managed by insinuating the point of the needle behind the posterior transverse sclerite. The suctorial surface thus freed consists only of integument, and can be induced to lie flat much more easily. The creasote is then removed and the object mounted flat in a drop of diluted balsam. The integument is pliable so long as it remains in creasote; it stiffens at once in the presence of xylol. Other specimens may advantageously be made, showing the entire organ in different attitudes.

FIGURE 501. *Calliphora vomitoria*, anterior end of central basal region of suctorial pad. The scleritic junction with the anterior basal canal is seen to be composed of twinned sclerites of similar pattern. The bodies of the teeth are seen, though their points are not in focus. It will be observed that the sclerites of the canals simulate a spiral, but are really separate and detached elements. × 300.

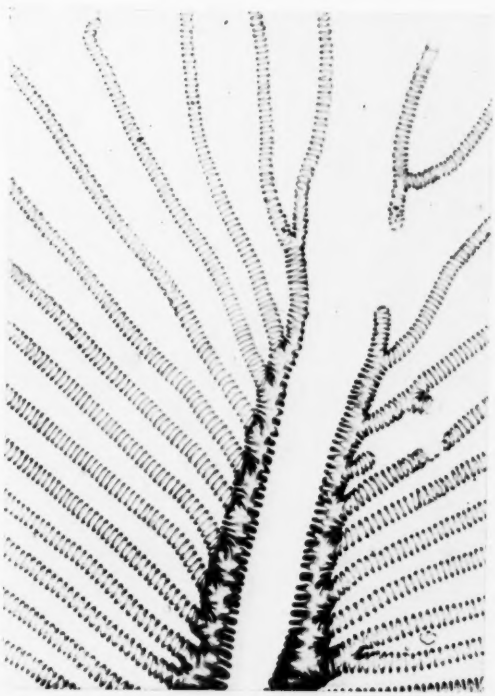

FIGURE 502. *Musca domestica*, anterior part of suctorial pad, showing anterior basal row of sclerites of each side, with the secondary canals derived from them. Some of their sclerites are focused for the back of the "C," and appear as transverse lines; others for the open front, showing a varying pattern of angles or curves. In the membrane itself there are a few small circles, looking like the roots of hairs; these appear to have a sensory function. × 300.

The figures are from photographs taken with Graetzin incandescent gas burner, Kohler lens-system, aplanatic condenser, sixteen millimetres apochromat, and eighteen millimetres compensating ocular, all by Zeiss. Ilford Process plates were used, and Imperial Process developer; the exposure (according to the equation) in the case of Figure 501 was seventy seconds. A longer exposure was tried for the next illustration (Figure 502) at one hundred and twenty seconds, when fine results were obtained, and the thinner and sharper lines thus produced show well in the reproduction. My equation was based upon a large number of experiments made with a more rapid developer; this present one is slower, but gives much more detail, is quite clean in working, and certainly the most useful for this purpose that I have yet tried. The full aperture of the objective was used, the condenser iris being set only to exclude extraneous light.

E. W. BOWELL.

THE ROYAL MICROSCOPICAL SOCIETY.—A conversazione was held at King's College, Strand, on Wednesday, October 16th, the President and Mrs. H. G. Plimmer receiving the guests.

The gathering was an unusually large one, and many of the exhibits were of exceptional interest.

In the Lecture Theatre a cinematograph display of Pond-life was given by Mr. E. J. Spitta, L.R.C.P., F.R.M.S., and this was followed by a lecture entitled "Insects as Carriers of Disease," by Professor R. T. Hewlett, M.D., F.R.M.S., illustrated with lantern slides.

Mr. Max Poser, F.R.M.S., gave a demonstration of "Liquid Crystals," which were shown on the screen, both in the solid and liquid phases, by means of a projection apparatus.

Among the many exhibits in the Large Hall were an Ultra-microscope Photo-micrographic apparatus, shown by Mr. J. E. Barnard, F.R.M.S., and an Abbe Diffraction Microscope; Quartz Mercury Vapour Lamp, by Messrs. J. E. Barnard, F.R.M.S., and Powell Swift. Photomicrographs and slides, showing the interesting "Mitotic Phenomena," were shown by Messrs. E. J. Sheppard and H. F. Angus.

The "Edinger Drawing and Projection Apparatus" was contributed by Mr. J. W. Ogilvy, F.R.M.S., with photographic apparatus, and photo-micrographs by the "Three Colour Process." There were also shown some examples of "Brownian Movement" by Dr. G. P. Bate, F.R.M.S.; a complete Optical Bench, by Messrs. R. & J. Beck; Diffraction Experiments, by Mr. J. W. Gordon; Slides and Photographs of Foraminifera, by Messrs. E. Heron-Allen and Arthur Earland, F.R.M.S.; Mycetozoa, by Mr. C. H. Huish, F.R.M.S.: Trypanosomes, by Professor Minchin, F.R.S.; Stereo-photomicrographs in colour of water-mites, by Mr. H. Taverner, F.R.M.S.; Chemical Reactions, by Professor Herbert Jackson; Micro-spectra Camera, by Mr. Julius Rheinberg, F.R.M.S.; Interference Figures in Crystals, by Mr. Powell Swift; Foraminifera, by Mr. Ernest Heath, F.R.M.S.; An old Microscope, by Professor Dendy, F.R.S.; Photo-micrographic Apparatus and various Slides, by Mr. Chas. Lees Curties, F.R.M.S.; Metallurgical Sections by Mr. Max Poser, F.R.M.S.; and Saccharomycetes by Messrs. A. Chaston Chapman, F.R.M.S. and R. L. Collett.

Another feature arranged by Mr. D. J. Scourfield, F.R.M.S., was a exhibition of Pond-life, due to the combined efforts of Fellows of the Society and to various members of the Quekett Microscopical Club.

THE QUEKETT MICROSCOPICAL CLUB. — On October 22nd, 1912, Messrs. Heron-Allen, F.L.S., F.R.M.S., and A. Earland, F.R.M.S., lectured on "The Foraminifera as World Builders." Reference was made to the "discovery," half-a-century ago, of *Eozoön canadense* in the Laurentian rocks of Canada. Although by general consent *Eozoön* is now relegated to the mineral kingdom, Mr. R. Kirkpatrick has recently announced in *Nature* that he is in possession of fresh evidence of the foraminiferal nature of *Eozoön*, and will shortly publish it. From the point of view of the lecture definite proof of the rhizopodal character of *Eozoön* would be welcome, as it occurs in enormous reefs in Canada and elsewhere. There are at present no definite records of Foraminifera in Pre-Cambrian rocks, but in Cambrian strata we find the group flourishing and already marked by widely separated types. In Silurian times Foraminifera were not numerous, and in the Devonian there is but a single record (by Terquem, at Paffrath in the Eiffel). In the Carboniferous, however, Foraminifera begin to be "World Builders," the large arenaceous form, *Saccammina fusuliniformis* McCay (= *S. Carteri* Brady), being the principal constituent of enormous areas of limestone in Great Britain and on the Continent. In Permian, Permo-Carboniferous, Triassic, Jurassic, and even Cretaceous rocks, while the number of genera and species multiply enormously, they do not form any important proportion of the whole bulk of the formations. With the Tertiary period we reach the Golden Age of the Foraminifera, the age in which they were to reach their maximum development both as regards size and abundance, and to leave their remains in great beds extending across whole continents, and often of enormous thickness. With the passing of the Eocene the Foraminifera lose their all-important position as rock-builders. The genus *Nummulites*, which with *Alveolina* built up enormous areas of limestone extending across Southern Europe to the Himalayas, dies out and dies so completely that at the present day it is represented by only a single small species of rare occurrence in tropical seas. The Miocene and later Tertiary deposits, though often presenting an abundant and extremely varied Foraminiferal fauna, no longer owe their existence to the occurrence of one or few species in enormous numbers.

To-day, the activity of the Foraminifera is displayed in another sphere. In the surface-waters of the great oceans the few genera which are found swarm in countless numbers, and, their dead shells falling constantly to the sea-floor, are there building up layers of *Globigerina* ooze over an area, according to Murray and Renard, of more than forty-nine and a half million square miles, exceeding that covered even by the Nummulitic limestone. Of the thickness of the ooze we can form no idea, but as the great oceans are practically permanent it must be very great, because we know from deep-sea deposits which have been elevated into land-surfaces in Malta, Australasia, and elsewhere, that similar deposits have been forming in the deep-sea since at least Miocene times.

PHOTOGRAPHY.

By EDGAR SENIOR.

EXPOSURE TABLE FOR DECEMBER.—The calculations are made with the actinograph for plates of speed 200 H. and D., the subject a near one, and the lens aperture F.16.

Day of the Month.	Condition of the Light.	Time of Day.		
		11 a.m. to 1 p.m.	10 a.m. and 2 p.m.	9 a.m. and 3 p.m.
Dec. 1st	Bright	·3 sec.	·4 sec.	·75 sec.
,, ,,	Dull	·6 ,,	·8 ,,	1·5 ,,
Dec. 15th	Bright	·4 sec.	·5 sec.	1·0 sec.
,, ,,	Dull	·8 ,,	1·0 ,,	2·0 ,,
Dec. 30th	Bright	·4 sec.	·5 sec.	1·0 sec.
,, ,,	Dull	·8 ,,	1·0 ,,	2·0 ,,

Remarks.—If the subject be a general open landscape, take half the exposures given here.

PHOTOGRAPHING COLOURED OBJECTS.—It is now generally known even among beginners that in a photograph of a coloured object, taken upon an ordinary plate, the relative value of the colours "as regards their luminosity" are very badly rendered. Blues photograph too light, while yellow and red are reproduced much too dark. The explanation, as is now well-known, lies in the fact that the silver salts employed are far more sensitive to blue and violet than to any other colour, with the result that blue becomes fully exposed almost before any action has taken place from the yellow and red. From the earliest time this was a great source of trouble to the photographer, and Crookes in 1858 suggested the use of a yellow screen, placed in front of the plate, as a means of improving the colour luminosities; but with plates of the low sensitiveness in use at that time such a device was of very little value. With the introduction of the gelatine plate, with its greatly increased speed and general sensitiveness, it was found possible, by employing an extra-rapid plate and a suitable screen, to obtain negatives of coloured objects, in which the luminosities of the colours represented were practically correct. The improvements, however, were at the expense of greatly prolonged exposure. The discovery of the sensitizing action of certain dyes when added to gelatine emulsions at once removed this difficulty, and placed a really practical method at the disposal of photographers. Quite early in the history of photography it had been found possible greatly to modify the sensitiveness of silver salts by the addition of various substances to them; about 1873, Dr. H. W. Vogel found that the addition of aurine to collodion emulsion resulted in an

additional light action in the green of the spectrum. Following up this discovery he finally stated that the addition of certain dyes to an emulsion rendered the silver salts sensitive to the less refrangible rays of the spectrum. The value of eosine as a colour sensitizer was discovered by Waterhouse, in 1875, and in 1879, Ives published his discovery of the orthochromatic effect obtained by the use of collodion emulsion treated with chlorophyll. In 1883, a patent was

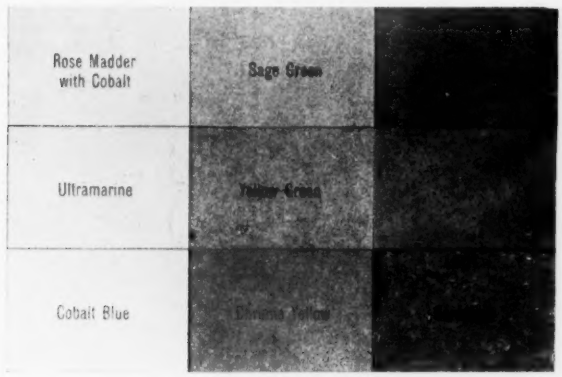

FIGURE 503.

Photograph of a coloured rectangle, taken on an ordinary plate.

obtained by Tailfer and Clayton, for a method of rendering gelatine emulsion orthochromatic by means of eosine together with ammonia, and plates prepared under this patent were placed upon the market by Messrs. B. J. Edwards & Co., in the following year. Orthochromatic plates, therefore, are those in which a dye or dyes, and sometimes a dye compound with silver, have been added to the sensitive salt, in order to impart sensitiveness towards the brighter colours of the spectrum. The use of such a plate by itself, however, is not found sufficient in practice, as, owing to the still greater

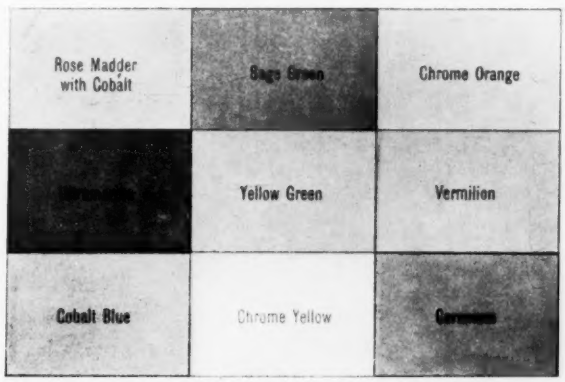

FIGURE 504.

Photograph of the same colours used in Figure 503. but taken on a panchromatic plate.

sensitiveness of the emulsion to blue and violet light, these colours impress themselves too strongly. In order, therefore, to obtain a correct representation in monochrome of the relative luminosities of the various colours in the subject photographed, a light filter has to be used to subdue the too active blue and violet rays, as well as to prevent the action of any ultra-violet light. It is also of importance that this light filter should be properly adjusted to the plate intended to be used with it, and that it should not needlessly prolong the exposure. Of late, dyes have become available which not only greatly increase the general sensitiveness of plates treated with them, but especially do so to yellowish light, and to such an extent that it is possible to obtain pronounced orthochromatic effect with much lighter screens, thereby reducing exposure. The great improvement obtained in the rendering of extreme distances, the variety of gradation in foliage, as well as cloud effects upon the same negative, resulting from the use of these plates and suitable filters, are now generally known, and even when employed without a screen, when working late in the evening or on dull days, they will give better results than an ordinary plate. One thing that should be carefully guarded against is "under-exposure," as its effects appear to be unduly pronounced with these plates, when employed with a screen. Perhaps one of the difficulties experienced is when to use a screen. This should always be done when a large amount of blue enters into the colour of the subject, such as blue sky with white clouds, distances, and so on, or in photographing landscapes on a dull day, when the greens will be improved by its use. Although the introduction of orthochromatic plates was a great step in advance, still when dealing with objects containing much red they fell far short in giving the desired result, owing to the dyes used not imparting sensitiveness to these colours. During the last year or two plates have been placed upon the market which are practically sensitive to the whole of the visible spectrum, and when used in conjunction with a properly adjusted light filter, will render colours very nearly correct as regards their luminosities when translated into monochrome. In the illustrations are seen two examples from negatives taken of rectangular patches of colour, Figure 503 being from an ordinary plate, while Figure 504 was photographed upon an Ilford Panchromatic plate with a screen. The striking difference between the two is at once apparent and serves to illustrate the great advantage of this class of plate in photographing coloured objects, especially if they contain much red.

ZOÖLOGY.

By PROFESSOR J. ARTHUR THOMSON, M.A.

REPRODUCTIVE PERIODS OF BIRDS.—It has often been pointed out that the reproductive periods in birds are usually well-defined, and that the sex impulse is precisely punctuated. But A. Chapellier has recently called attention (*Comptes Rendus Soc. Biologie*, LXXII.) to cases of sexual activity outside the breeding season. He instances the autumnal pairing of wild duck, American swallows, "Bluebirds," *Progne subis*, *Elanus dispar*, *Strix perlata*, and *Otus brachyotus*. He asks whether there is not considerable evidence of an autumnal period of sexual excitement among birds,—expressed not only in pairing, but in song, attempts at nest-making, and combats.

VIBRATILE FIN OF THE ROCKLING.—The three-bearded rockling (*Motella tricirrata*) and the five-bearded rockling (*M. mustela*) are familiar shore fishes—shy, nocturnal, phlegmatic, and non-predaceous. They are fond of lurking under stones between tide-marks, and feed on crustaceans, annelids, starfish, sea-spiders, and the like. Conspicuous on their back is a modified dorsal fin, consisting of a series of small processes, which are almost continuously in rapid vibration, and, anterior to these, a ray which is much longer and thicker than the others, and has much less power of movement. Around the base of the rays there is a groove, and bordering this the skin is kept clear and clean. It has been suggested that this vibratile fin, whose movement is conspicuous (observable from three to six feet in the still water of an aquarium), may serve as some sort of "lure"; but Dr. J. Stuart Thomson brings forward strong evidence pointing in another direction—to the use of the vibratile fin, or the area immediately around it, as a taste-organ or food-locating organ. The skin around the groove proves to be very rich in taste-buds, and experiments show that this area is extremely sensitive to the proximity of food. The vibration keeps the "receptor" area clean, and brings to it currents with their subtle indications of available food material.

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BIOLOGICAL SCIENCE AND THE PEARLING INDUSTRY.

A few comments on Dr. Jameson's Paper published in "KNOWLEDGE," Vol. XXXV (November, 1912), p. 421.

By T. H. HAYNES.

THE admirable summary that Dr. Jameson has drawn up of the biological and economic aspects of the pearl and pearl-shell industries may be regarded as the sole publication of the kind existent, and its value is self-evident. It comes at an opportune moment when a Federal Royal Commission is sitting in Australia to inquire into the pearl-shelling industry, and the State Legislatures of Western Australia are discussing a new Pearling Bill that is designed to confer security of tenure upon would-be cultivators, and to establish a fund for promoting the culture of pearl-shell. The motive power behind the Commission and the new Bill is the determination to turn tropical Australia into a white man's country, and the pearling industry, which is the only occupation which employs any substantial number of people, into a white man's industry. It is, therefore, of the highest importance that the information available for the Royal Commission should be of a sound character, so that erroneous ideas and false hopes may not be perpetuated, and I think that through the good offices of "KNOWLEDGE" these aims will be secured.

Dr. Jameson has cleared the air on several important points, viz. :—

The distinction between pearls and "blisters" and the delusion that exists that any progress has been made in the artifical production of pearls.

The futility of endeavouring to breed pearl-oysters without an enclosure.

The difference between true cultivation by breeding from parent stock and semi-cultivation by the transplantation of natural-grown young shells to private ground.

The difficulty of distinguishing between the young of the true pearl-shell and the false "reef" or "bastard" variety.

In my "statement of evidence" which I have sent out to the Royal Commission, I have dealt with these subjects very much in the same way as Dr. Jameson has done, and I have also referred to the friendly controversy which exists between him and myself regarding the 1910–11 experiment at the Montebello Islands. Dr. Jameson disputes my claim to have raised young pearl-shells (*Margaritifera maxima*) from the parent stock in my pond, and I am glad of the ready permission of the Editors of "KNOWLEDGE" to defend my case, and to repeat the arguments which I laid last year before Mr. H. C. Dannevig (the Federal Director of Fisheries in Australia) and have now sent to the Commissioners.

1. In the first place let me say that the amount of water flowing automatically into the pond, on the flood, varies very much according to the state of the tide, rising springs, falling springs and neaps. The result is the main thing. The temperature and salinity remain normal and the parent-stock thrives in a marked manner. So also do young reef-shells.

2. Trial specimens opened for examination showed signs of spatting early in November, the gonads exuding ova or milt when severed by the knife. The bulk of the parent-stock was opened at the end of March, and the exudation was more profuse then than in November and December, but shells from the open sea, especially from deep water had by that time ceased to show any exudation when cut.

3. I commenced operations by closing the pond on November the 21st. On November the 29th the water inside suddenly became very blue and did not recover its normal appearance until December the 3rd. No such change had ever been noticed before. On December the 9th young oysters of the size of pinheads were found on some of the collectors near to the breeding-stock trays. On December the 29th another batch appeared, and a still more copious batch on January the 3rd, and doubtless others occurred which were not noticed. These young oysters in shape would pass either for pearl-shells or bastard-shells and the byssus attachment was visible with the glass. They varied in number on each stone collector—up to fifty or sixty. Every effort was made to rear them, some in the pond and some slung in cages in the open tideway; but without success, as they quickly began to disappear, and within a fortnight or so each batch had completely vanished. There were no fragments of shell left and they must deliberately have detached themselves and probably fell into the film of mud or sediment at the bottom and were smothered or devoured by bottom vermin. On February the 6th, a hurricane blew my house into the sea and I lost everything in it, including the mounted specimens of these young oysters. No further notes were taken as to what was going on in the pond, but numerous other batches of young shells probably came into existence and disappeared in like manner.

4. Here and there about the pond I found an odd shell on the collectors, of much larger growth, widely

scattered. These were kept under observation in the pond under similar conditions as the pinhead shells. None of them showed any disposition to shift although they were frequently handled, and when I opened them on the 9th April, the colour of the animal within showed them to be bastard-shells as I suspected.

5. True pearl-shells are not found on hard rock bottom, but "reef" or bastard-shells are very commonly so found. I submit that the pinhead oysters were true pearl-oysters attached to stone for want of a better place, and that they shifted in search of one; whereas the others which proved to be "reef" shell did not shift. The reef-shells must undoubtedly have come in with the tide-water and they were widely separated. I contend that if the pinhead oysters came in with the tide inrush of water they, too, would not have been found congregated thickly together, but would have been scattered more generally over the pond. Consequently, I claim that they were the progeny of my parent stock in the pond. Dr. Jameson is of a contrary opinion, but Mr. Dannevig is not so. His Report to the Minister on his interviews with me in Melbourne last year, has been laid before the Royal Commission, therefore I may fairly be allowed to quote from it as follows:

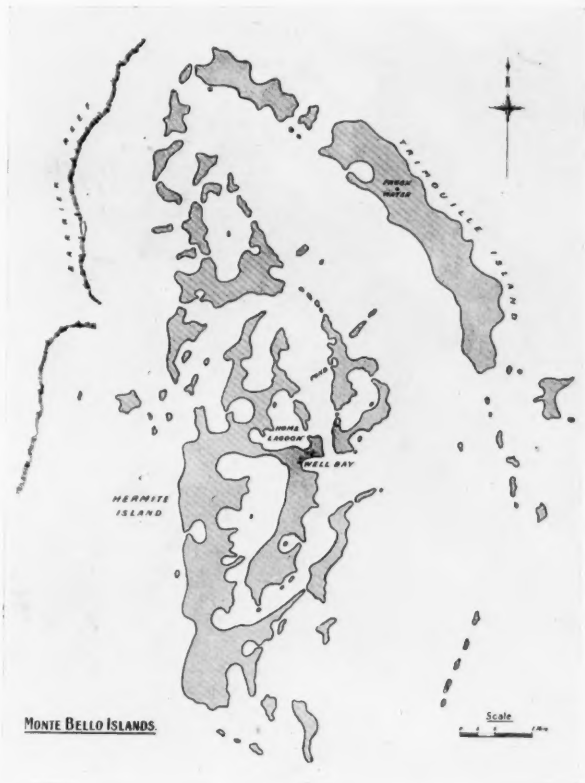

FIGURE 505.
A Chart of the Montebello Islands.

"He (Mr. Haynes) is unable to positively say the 'brood' were genuine pearl-oysters, as they were too small for identification, but the inference that they were is very strong."

6. Regarding paragraph two, Dr. Jameson does not think that any of the breeding stock which was undoubtedly showing signs of spawning in November, ever discharged any portion of their products, ova or milt, in the pond at all, and that they had not done so even at the end of March, when they were still surcharged, and he is of opinion that the female discharges the whole of her eggs in the course of a few hours. If this is so, her period of preparation—five months—seems a very long one and with all deference to my friend, Dr. Jameson, I venture to doubt it. Moreover, that argument leaves untouched the facts that the pinhead oysters were closely congregated and would not stay on the stones, whereas the young reef-shells were found singly, the total number was very small, and they stayed where they were.

The Montebello operations were closed after the hurricane, partly for want of funds and partly because, in the absence of any security of tenure and a previous cancelment of the lease in 1906 by the Newton Moore Government, it was impossible to obtain or even ask for any further support. It has been reserved for a Labour Ministry at last to do justice to the case, and the difficulty of security of rights is now being removed. The operations ought soon to be resumed, but nothing can be done before the spatting season commencing in November, 1913, beyond the work of preparation and the putting up a new homestead. The problem of rearing the young shells may take as long a time to solve as that of lobsters, in 1898, in the hands of the United States Fisheries Commission, and a constant circulation of water by artificial means may similarly be required. Seven years may possibly be absorbed before marketable shell can be produced, and the venture turned into a commercial success; in no case can it be less than four years, and the amount of money required is so considerable that it will be extremely difficult to find English supporters; but the possibility of financial assistance being accorded by the West Australian Government may facilitate matters. It is impossible, however, to leave Dr. Jameson's challenge unmet.

One subject only remains to be dealt with here. Dr. Jameson has pointed out that cultivation of pearl shell is directly opposed to the interests of the owners of the pearling fleets now in existence. Mr. Male, the member for Broome, the pearling port, criticised the new Pearling Bill, and amongst other things he maintained that the great North-West pearling grounds were unsuitable for cultivation purposes and he could not think of a single place which was sufficiently protected.

The chart of the Montebello Islands will show that sheltered ground exists there to an ideal extent that is unequalled, to my knowledge, in any part of the world, and the pearl-shells found there, weighing up to fifteen pounds apiece, are the finest in the

world. The only disadvantages are that the islands lie ninety miles from the mainland; that there is no mail communication with them, and they are uninhabited. Dr. Jameson wonders why Saville-Kent wanted to grow pearl-shells at the Abrolhos, far south of their natural habitat. I can tell him! Kent found that there was a warm water current, and conceived the idea that pearl-shells might do there. He obtained concession rights there and tried to float a company in London for £100,000, and induced me to put my name to it. After a week's reflection, however, I withdrew my name, as the closer I studied it the less I liked it—and the Company was never formed. The project could have been worked very comfortably from the town of Geraldton, not far distant; but the want of sheltered waters and of any large extent of mud bottom to afford a large food supply was alone sufficient to deter a prudent man from encouraging the idea.

REVIEWS.

PHOTOGRAPHY.

Telephotography. — By CYRIL F. LAN-DAVIS, F.R.P.S. 127 pages. 16 full-page plates and 7 diagrams. 7¾-ins. × 5¼-ins.

(George Routledge & Sons. Price 2/- net.)

The author of this book has produced a useful and interesting little volume dealing with the subject of Telephotography, and one which should be extremely valuable to the practical worker. The work not only deals with the subject in its relation to distant objects, but explains in an equally clear manner its value in photographing near ones, an important application frequently lost sight of. In explaining the advantages of the Telephoto system for distant objects, comparison is drawn between the size of the images given by a five-inch and twenty-inch focus lens respectively, and then it is shown how by the use of a Telephoto combination consisting of a five-inch positive and a two and a half-inch focus negative lens, and seven and a half inches of camera extension, the size of the image would be the same as that given by a twenty-inch focus lens and requiring practically that extension of camera. The Telephoto lens thus places the means at our disposal of obtaining large pictures with only small extension of camera. In discussing the use of these lenses for near objects, the author gives an example in which the camera extension is only a little more than half that required by an ordinary lens for the same size of image, with the object several feet further off, thus giving improved perspective. Examples are also given of rapid Telephoto lenses which are mostly of fixed focus, and so only give one degree of magnification for distant objects. The large Adon manufactured by Messrs. J. D. Dallmeyer is of this type and works at from F. 4·5, F. 6 to F. 10, and is supplied in focal lengths suitable for obtaining pictures of from two to four times the usual size, and can be employed on reflex cameras where the image is focused up to the moment of the exposure. Some interesting remarks are also made regarding the exposure required for distant objects. Theoretically, this should be proportional to the square of the magnification, but practice has shown that it is better to take one-half of this when working without a screen, and only give the full time when using a properly-adjusted light filter. The book, which is clearly written, contains numerous examples illustrating the various applications of Telephotography, as well as carefully compiled working data, and should certainly be studied by all those interested in this branch of photographic work.

E.S.

ZOOLOGY.

Reptiles, Amphibians, Fishes, and Lower Chordata.—By RICHARD LYDEKKER, J. T. CUNNINGHAM, M.A., G. A. BOULENGER, D.Sc., F.R.S., and J. ARTHUR THOMSON, M.A. 510 pages, 4 plates in colour, 23 in monotone, 1 map, and many text figures. 9-in. × 6-in.

(Methuen & Co. Price 10/6 net.)

This volume is a companion one to a History of Birds written by Mr. W. P. Pycraft, the general editor of the series, but as it deals with Reptiles, Amphibians, and lower Chordata; it is the joint work of several well-known naturalists and it has been edited by Mr. J. T. Cunningham. The volume is by no means an ordinary text book and it deals with Natural History in a general sense rather than with classification. We find discussed in detail, adaptations, coloration and its interpretation, life-histories and modes of reproduction. The consideration of reptiles gives an opportunity of tracing their pedigrees and relationship. Under the heading of Fishes, the phenomena of sex are dealt with, as well as the production of sound, light and electricity. In every way this is a modern book, written, produced and illustrated in a modern way.

W. M. W.

NOTICES.

CORRECTIONS.—Mr. Henry Faulds points out that there is a mis-spelling on page 440, namely "Hari-kari," for the Japanese "Hara-kiri." He believes that the first form has got into some dictionaries, but it is absolutely wrong.

In Mr. Redgrove's review of Dr. Dakin's book, an addition made by him on his proof was inserted at the wrong point. In the sixth line from the bottom of the review on page 442, for "in the body" read "when perfused through a surviving liver" and next line for "when perfused through a surviving liver" read "is produced."

MR. LEITZ HONOURED.—Recently the Faculty of Medicine of the University of Giessin conferred the honorary degree of Doctor of Medicine upon Ernst Leitz, Junior, the junior partner of the celebrated optical firm of E. Leitz, of Wetzlar, and 18, Bloomsbury Square, London.

It is only a little more than a year since the University of Marburg honoured the senior partner of the same firm by conferring upon him the degree of Doctor of Philosophy.

We congratulate Messrs. Leitz on the fact that their services to Science have been so properly and suitably recognised.

MR. EDWARD BAKER'S CATALOGUE.—We have received the three-hundred and fourth catalogue of more than one thousand books on sale at Edward Baker's Great Book-Shop, Birmingham. Among them are many first editions, limited issues, and presentation copies, as well as a number of American Transactions.

THE "LONDON" MICROSCOPE.—Our readers will be interested to hear that Messrs. R. & J. Beck, Ltd., have produced a new microscope. A special feature of it is the large and heavy base, which ensures perfect rigidity when it is in a horizontal as well as in a vertical position. There is a specially smooth-working and reliable fine adjustment, while the stage is four inches square, and the instrument is finished in Messrs. Beck's special black enamel which withstands the actions of acids and spirit.

BOTANICAL WORKS.—We are pleased to draw attention to Messrs. John Wheldon & Co's. handily arranged catalogue of botanical books. The contents are arranged under three main headings: Economic, Geographical, and General. Each of these is again sub-divided so that the list referring to any particular branch of botanical science can easily be consulted.

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